X-47

MAINTENANCE MANUAL

COACH

MODEL

PD-3751

GMC TRUCK & COACH DIVISION
GENERAL MOTORS CORPORATION
PONTIAC, MICHIGAN

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INTRODUCTION

This manual includes complete operation and repair information on Coach Model PD-3751.

The information is conveniently arranged in the manual according to important groups. Each group or section of a group treats with a major unit or system of the vehicle. The procedures contained in each group are recommended for efficient service.

By referring to the various indexes in succeeding pages, important subjects can be readily found in the manual.

GMC TRUCK & COACH DIVISION
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HOW TO USE THIS MAINTENANCE MANUAL

(READ THIS PAGE BEFORE USING MANUAL)

This manual includes general data, operation, maintenance, and repair procedures on all important systems and units of GM Coaches for models listed on Page 1. With an understanding of the text arrangement and by reference to the proper index, instructions and data can be readily found.

MANUAL ARRANGEMENT

MAJOR GROUPS—The sections of the manual are numerically arranged in sequence by Major groups such as O. Operation, 1. Front Axle, 2. Rear Axle, etc. The manual location of each group or section can be quickly found by referring to the "Quick Reference Group Index." A black tab bearing the major group number is placed on the first page of each section in relatively the same location as like tabs on page 3.

SECTIONS—Many of the major groups are divided into separate sections, each section including specific information on units or important phases of the group. As an example:

The Brake System (Group 4) is divided into three sections—i.e., Sec. 4B Air Brakes, Sec. 4C Air Compressor, and Sec. 4D Hand Brake. The page number, section number, and name of section appear in the upper left- or right-hand corner of each page.

PAGE AND ILLUSTRATION NUMBERS—The manual pages are numbered consecutively throughout the manual. Illustrations are numbered consecutively within each manual section.

INDEXES

SECTION AND PAGE INDEX—The index on Page 8 shows all the sections as they appear in the manual with page number references and coach model application.

ALPHABETICAL INDEX — Pages 9 through 12 alphabetically list subjects with manual page number references.

SECTION CONTENTS—The important subjects included in each section are itemized on the first page of each section. In addition, related sections with page references are also itemized.

SPECIAL TOOLS

Special tools and equipment are mentioned and in many instances illustrated throughout the text. In some instances, such special tools are mentioned by Vendor's number in the text or illustrations. These tools are listed at the end of section under the heading "Special Tools." This listing includes vendor numbers, and the names and addresses of the vendors from which tool prices, availability, etc., may be obtained.

SPECIFICATIONS—Service specifications, fits, and tolerances are listed at the end of each section under the heading "Specifications." These specifications include, if necessary, coach model application.

OPERATION—The first section in the book, Sec. O-Operation, includes important driving information. Use of controls and other useful information are included.

TROUBLE SHOOTING—The last section in the book, Sec. 21-Trouble Shooting, may be used to diagnose some of the common troubles which may be encountered.

SERVICE BULLETINS—Service bulletins are issued supplementing information in each section whenever necessary. The information contained in these bulletins should be noted in the text and the bulletin filed for future reference.

SUGGESTIONS—We are sure that you will find the instructions in this manual a reliable source of Maintenance and Repair Procedures on GMC Coaches.

Every effort has been made to make the contents of this manual accessible, readable, and accurate. Important construction features and procedures are illustrated and arranged in a practical sequence. Your suggestions for a further improvement of this manual are invited.

WARRANTY

GMC TRUCK & COACH DIVISION—GENERAL MOTORS CORPORATION warrants each new commercial motor vehicle, chassis, or part manufactured by it to be free from defects in material and workmanship under normal use and service, its obligation under this warranty being limited to making good at its factory any part or parts thereof which shall, within ninety (90) days after delivery of such vehicle to the original purchaser or prior to the time when such vehicle has been operated five thousand (5,000) miles, whichever event shall first occur, be returned to it with transportation charges prepaid and which its examination shall disclose to its satisfaction to have been thus defective; this warranty being expressly in lieu of all other warranties expressed or implied and of all other obligations or liabilities on its part, and GMC TRUCK & COACH DIVISION–GENERAL MOTORS CORPORATION neither assumes nor authorizes any other person to assume for it any other liability in connection with the sale of its vehicles.

This warranty shall not apply to any vehicle which shall have been repaired or altered outside of the Manufacturer's factory in any way so as, in the Manufacturer's judgment, to affect its stability, or reliability, nor which has been subject to misuse, negligence or accident, nor to any such vehicle made by GMC TRUCK & COACH DIVISION –GENERAL MOTORS CORPORATION which shall have been operated at a speed exceeding the factory rated speed, or loaded beyond the factory rated load capacity.

GMC TRUCK & COACH DIVISION—GENERAL MOTORS CORPORATION makes no warranty whatever in respect to tires, rims, ignition apparatus, horns or other signaling devices, starting devices, generators, batteries, speedometers or other trade accessories, inasmuch as they are usually warranted separately by their respective manufacturers.

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PONTIAC, MICHIGAN

GENERAL DATA

The data below includes only general information on models covered by this manual. Specific data and specifications will be found in "Specifications" section of each manual section. For convenience, index of general data items is shown below:

MODEL DATA

PD-3751

Wheel base.....264 in.

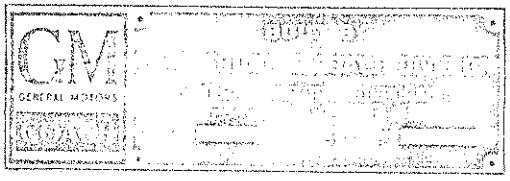
Tire Size.....11:00-19 Single front—Dual rear

Diesel Engine

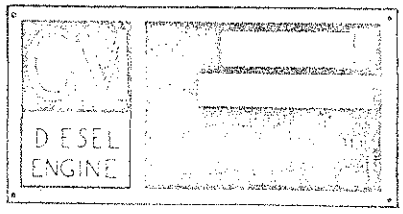
Model 6-71LA35	Governed Engine Speed (no load)
Piston Disp.—Cu. In 425.31	1st, 2d, or 3d gear—2100 rpm
Bore and Stroke.....4¼ in. x 5 in.	4th gear—1800 rpm
S.A.E. Horsepower.....43.35	Compression Ratio (nominal) 16:1

SERIAL NUMBER LOCATIONS

Delay and confusion can be avoided when correct serial numbers of vehicle are specified on parts orders and correspondence.



CHASSIS NUMBER PLATE ON INSIDE PANEL OF ENTRANCE DOOR



DIESEL ENGINE NUMBER PLATE ON LEFT HAND SIDE OF ENGINE

TP 3677

Chassis serial number is also stamped on longitudinal underframe rail in tool compartment.

MANUAL GROUP AND SECTION INDEX

The sections in this manual are grouped in sequence as shown in following index.

(1) Section 7A, Wiring and Misel. Electrical includes wiring diagrams and such electrical equipment that can not be included in other sections. Electrical units applying to various systems are included in respective system sections.

Index

INDEX

INDEX

INDEX

Operation

Contents of This Section

Related Subjects in Other Sections

Reference should be made to all other sections of this manual for more detailed information on the various major systems of the Coach.

This section includes information and instructions applicable to the operation of the coach from the standpoint of the driver. The information should also serve as an operational guide to the service personnel. In addition to the location and purposes of the controls and instruments, the proper methods of engine, transmission, and brake operation are explained. Use of lights, proper operation of heating and ventilation system, and the access to various units are also itemized. All of the information in this section is of vital importance to the operator, not to teach driver skill but to assist in the efficient operation of the particular GM Coach model covered by this manual.

LOCATION OF CONTROLS

All of the controls, instruments, gauges, and switches which are used by the driver in the operation of the coach are grouped in the driver's compartment as illustrated in figures 1 and 2.

The gauge and switch panels (fig. 2) includes switches, gauges, and signal lights which are used in the control of the engine and lights. The locations and names of these various controls as well as conventional hand and foot levers are clearly shown in the illustrations with their accompanying captions. Uses of the various controls are thoroughly explained in succeeding paragraphs.

In addition to the engine control switches on the instrument panel, sufficient controls are provided in the rear engine compartment to permit operation of engine from that point while accomplishing service on the power plant. The uses of these controls are explained under "Diesel Engine Operation" later in this section.

OTHER OPERATION INFORMATION

These coaches are equipped with Diesel engines. More detailed information regarding operation and maintenance of the Diesel engine will be found in a separate manual (Form No. X-4517).

Sufficient information has been included in this section on special equipment most commonly used. Information may be obtained from the factory on the operation of special equipment which may not be covered in this section.

UNIT ACCESSIBILITY

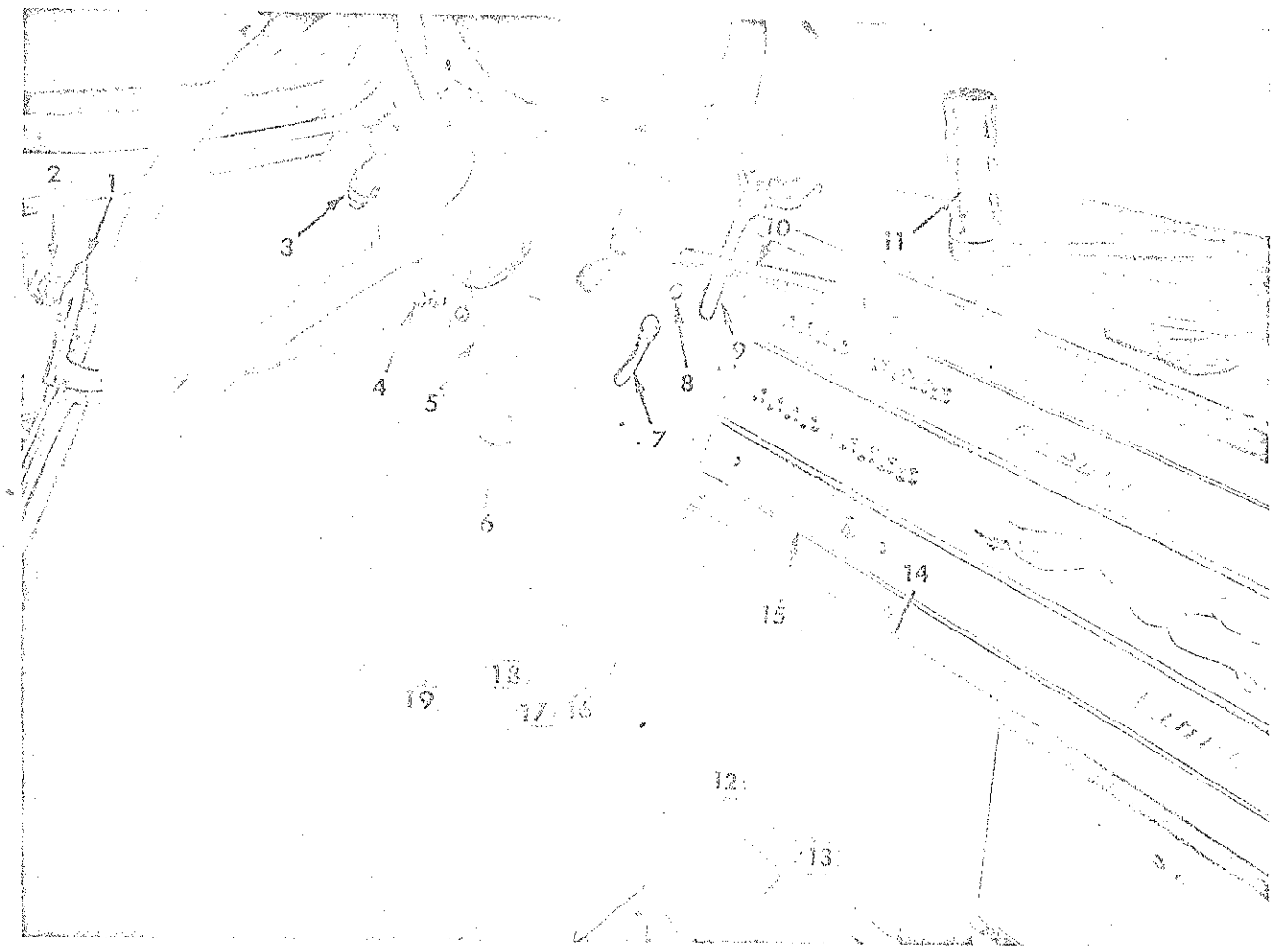
The vehicle is equipped with several doors which must be opened to permit access to various units for service, inspection, adjustment, or repair. Locations of these doors are shown in figure 3. In many instances the driver will have no occasion to utilize some of these access doors; however, the operator should have knowledge of such accessibility for emergency purposes.

INSIDE OF COACH

DESTINATION SIGN

Front destination sign crank is accessible through door above windshields. Door is opened with door lock wrench. Side destination sign crank (when used) is located above rear corner of entrance door.

OPERATION



1 Hand Brake Lever
2 Driver's Side Window Crank
3 Spot Light Handle
4 Windshield Wiper Valve
5 Gauge Panel
6 Driver's Ventilator Control
7 Directional Signal Control Lever
8 Directional Signal Tell-Tale
9 Manual Windshield Wiper Handle
10 Gearshift Lever
11 Door Control Lever
12 Brake Treadle
13 Accelerator Pedal
14 Hand Throttle
15 Switch Panel
16 Clutch Pedal
17 Fog Light Foot Switch
18 Headlight Dimmer Switch
19 Air Horn Foot Valve

TP 3574

Figure 1—Drivers Compartment

FUSE PANELS

Door in dash panel at right of center emblem provides access to fuse panel. Spare fuses are mounted on back of fuse panel door. Main fuse, starter circuit fuse, and engine compartment light fuse are located on control panel at right rear corner of body. Driver's blower switch fuse is located on buzzer panel.

SAFETY EQUIPMENT COMPARTMENT

Safety equipment compartment door, located below fire extinguisher, is opened with door lock wrench. Box on back of compartment door contains flares. Door also provides access to door control linkage.

OUTSIDE OF COACH

SPARE TIRE

Spare tire compartment is located at front of vehicle directly under headlights (fig. 3). Front bumper is mounted on tire compartment door.

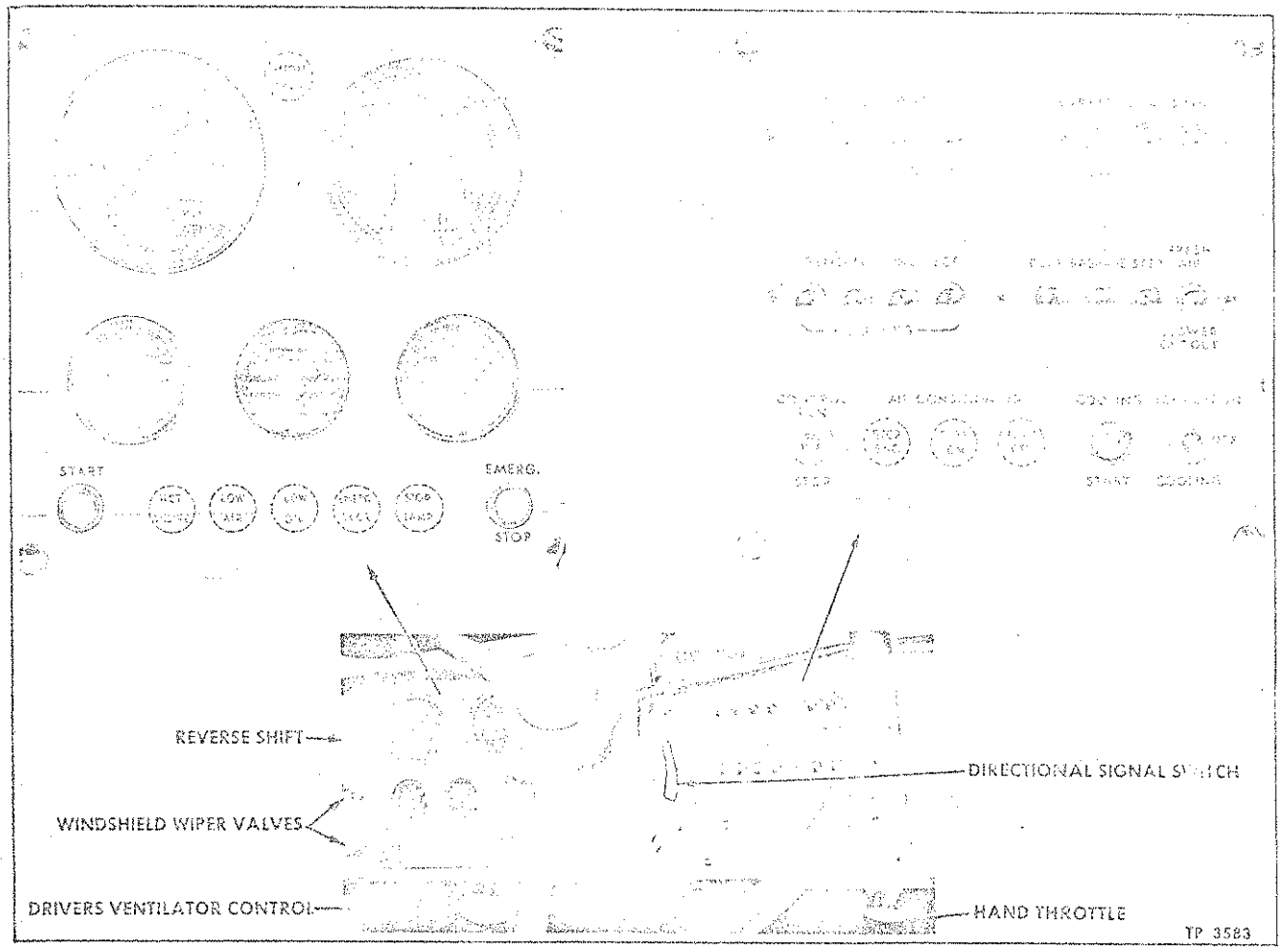


Figure 2—Drivers Gauge and Switch Panels

Sliding access door in bottom of tire compartment provides access to tire valve for gauging or inflating without removing wheel and tire.

TOOL COMPARTMENT

Tool compartment at left front corner of vehicle is accessible through tool compartment door (fig. 3). Door is opened with door lock wrench. This compartment contains jack, jack handle, flare, and miscellaneous tools. This compartment also provides access to air brake pressure test fitting and other air system units, and to lubrication fittings for clutch pedal shaft and steering mechanism.

FUEL AND WATER FILLER NECKS

Diesel fuel tank filler doors are located in right-hand rear side of body, one ahead of and one at rear of right-hand rear wheelhouse (figs. 3 and 4). Doors are opened by inserting finger in hole and pulling outward. Toggle springs hold doors in open or closed position.

Air conditioning engine radiator and fuel tank filler doors are in left-hand front side of body (fig. 3). Doors are opened in same manner as described above.

Diesel engine radiator filler is accessible through left-hand engine compartment door (fig. 3). Door is opened with door lock wrench.

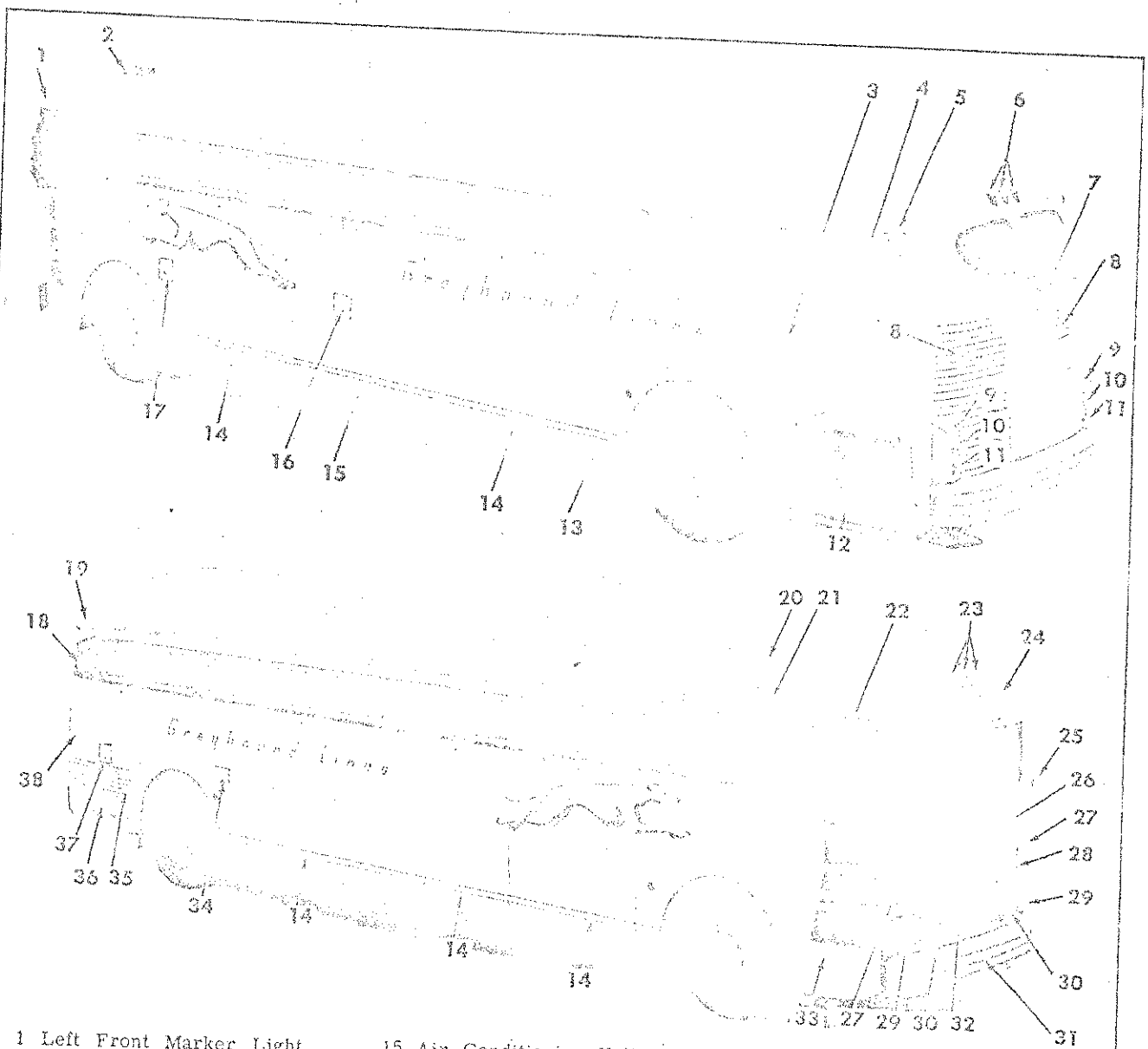
BAGGAGE COMPARTMENT

There are five baggage compartments on vehicles equipped with air conditioning, three on right-hand side of vehicle and two on left-hand side (fig. 3). When air conditioning is not used, air conditioning unit compartment is utilized as a baggage compartment. Baggage compartment doors are opened with door lock wrench. To secure doors in open position, pull chain out of tube and hook into slots in body below windows.

ENGINE COMPARTMENT

Two doors provide access to engine compartment for minor service operations, one at each rear corner of vehicle (fig. 3). Doors are opened with door lock wrench.

OPERATION



1 Left Front Marker Light
2 Fresh Air Intake Grille
3 Emergency Door
4 Engine Air Intake Louvre
5 Left Rear Marker Light
6 Rear Michigan Marker Lights
7 Target Sign
8 Engine Compartment Doors
9 Stop Light
10 Rear Directional Signal Lights
11 Taillights
12 Radiator Shutter Screen
13 Battery Compartment Door
14 Baggage Compartment Doors
15 Air Conditioning Unit Compartment
16 Air Conditioning Engine Radiator Filler Door
17 Air Conditioning Engine Fuel Tank Filler Door
18 Engine Air Intake Louvre
19 Right Rear Marker Light
20 Fresh Air Intake Grille
21 Side Destination Sign (Special Equipment)
22 Right Front Marker Light
23 Front Michigan Marker Lights
24 Front Destination Sign
25 Spot Light
26 Front Emblem
27 Front Directional Signal Lights
28 Driver's Ventilator
29 Head Lights
30 Fog Lights
31 Front Bumper (Spare Tire Compartment Door)
32 Door Release Button
33 Entrance and Exit Door
34 Front Fuel Tank Filler Door
35 Fuel Tank Selector Valve Access Door
36 Transmission Inspection Door
37 Rear Fuel Tank Filler Door
38 Rear Engine Control Panel and Regulator Compartment Door

TP 3606

Figure 3—Location of Compartment Doors and Exterior Lights

TRANSMISSION COMPARTMENT

Door on right-hand side at rear corner (fig. 3) provides access to transmission compartment for servicing or inspecting transmission and other units at rear (drive) end of engine. Door is opened with door lock wrench.

Small door in top forward corner of transmission compartment door (figs. 3 and 4) provides access to fuel tank selector valve without opening transmission compartment door. Small door is opened by inserting fingers between grills and pulling outward at bottom. Spring loaded toggle mechanism holds door in open or closed position.

BATTERY COMPARTMENT

Battery compartment is immediately ahead of left rear wheelhouse (fig. 3). Door is opened with door lock wrench. Safety chain is used to secure door in open position.

ENGINE FUSE AND RELAY PANEL AND REGULATOR COMPARTMENT

Door in right rear corner of body above transmission compartment door (fig. 3) provides access to fuse and relay panel and generator regulator. Generator circuit master fuse and spare fuse is located on this panel. Door is opened with door lock wrench.

FUEL, OIL, AND WATER

FUEL

Fuel tanks are mounted in body underframe, one ahead of and one behind rear axle. Filler necks are accessible through access doors located ahead of and at rear of left rear wheelhouse (fig. 4).

Fuel tank selector valve, accessible through small door in top front corner of transmission compartment door (fig. 4), connects both tanks to the engine fuel lines. Valve may be set to permit fuel to be used from front or rear tank only, or from both tanks.

Reference should be made to Fuel System (Sec. 12A of this manual) for specifications of fuel oil to be used in these coaches. Regular precautions should be taken when filling tanks to prevent static electricity sparks, and to prevent dirt, water, ice, or snow entering tank.

CRANKCASE OIL

Oil reservoir (fig. 4), mounted below radiator surge tank in left-hand side of engine compartment, carries a reserve supply of engine oil for replenishing oil supply in engine crankcase. Engine oil dipstick (fig. 4) is graduated to show level of oil in crankcase. Oil reservoir and dipstick are accessible through left-hand engine compartment door.

After determining quantity of oil required by checking oil level on dipstick, oil is added to engine crankcase by turning valve at top of oil reservoir to the required quantity (fig. 4). Leave valve handle in this position; do not turn handle to "OFF" position except when refilling reservoir. As an example, if two quarts of oil are required in engine crankcase and oil reservoir is full, turn handle to "2" and leave in this position; the nest time two quarts are required in crankcase, turning handle to "4" will permit the required two quarts of oil to drain from reservoir into crankcase. Dipstick on oil reservoir filler cap shows level of oil in reservoir.

When refilling engine crankcase after draining oil, oil is added through oil filler at rear end of engine (fig. 4). Oil filler is accessible through right-hand engine compartment door.

Refer to Lubrication (Sec. 13 of this manual) for engine oil recommendations.

WATER

FILLER CAP

Engine cooling system filler cap in on the surge tank (fig. 4), mounted in upper left-hand corner of engine compartment and accessible through engine compartment left-hand door.

Filler cap has a safety catch which permits the cap to open slightly when filler cap handle is released. If coolant is hot when opening filler cap, stand to one side when releasing handle to prevent being burned by escaping steam. Do not release safety catch until all steam has escaped. After pressure in system has been relieved and steam has stopped escaping, release safety catch and open filler cap. When closing filler cap, make sure safety catch engages edge of cap.

FILLING SYSTEM

To Fill System After Draining

1. Close all drain cocks and install drain plug in radiator outlet connection. Open vent cock at top of thermostat housing. Open radiator filler cap.
2. Fill system to level of filler cap opening.
3. Close vent cock and filler cap.
4. Start engine and run for a few minutes. With engine running, water required to fill heating radiator is drawn from surge tank. The surge tank can then be filled again to level of filler cap opening.

OPERATION

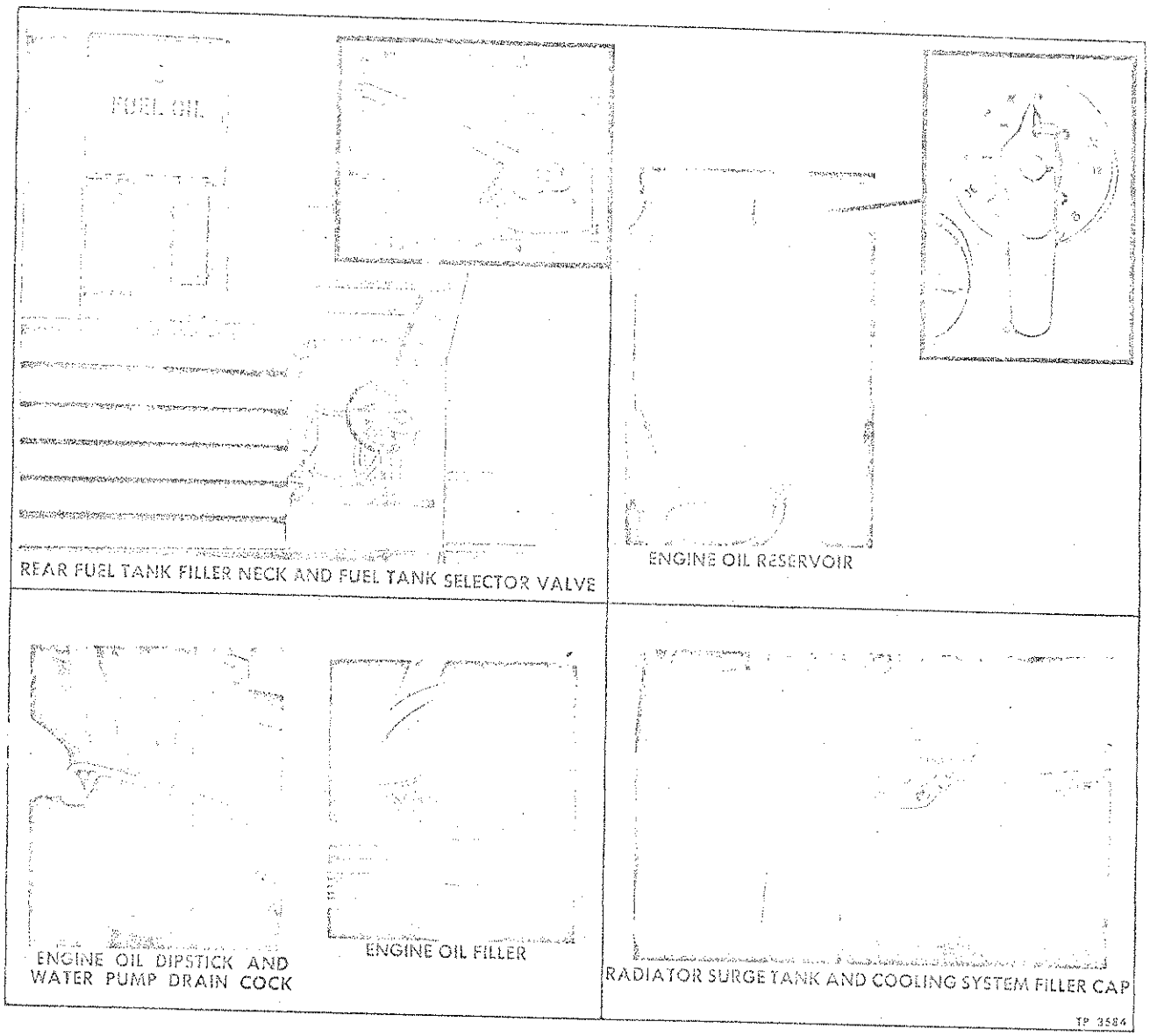


Figure 4—Fuel Oil, Engine Oil, and Water Service Points

To Add Water to System

1. Open radiator filler cap. CAUTION: If coolant is hot, follow instructions previously given under "Filler Cap."

2. With engine running, add water to level of filler cap opening.

3. Should water be lost from cooling system, and engine becomes overheated, do not add cold water immediately - wait until boiling has ceased and engine cooled down. Then, with engine running at idling speed, add water slowly to level of filler cap opening.

CAUTION: Cold water should never be poured into cooling system when engine is hot, as the sudden change in temperature may cause a cracked cylinder head or block.

DRAINING SYSTEM

1. Open filler cap on radiator surge tank, CAUTION: If coolant is hot, follow instructions previously given under "Filler Cap."

2. Open drain cocks and remove drain plug. Drainage points are located as follows: Drain cock at bottom of water pump housing; drain plug in radiator outlet connection at lower rear corner of radiator; drain cock in lower left-hand corner of heating radiator, accessible through left front baggage compartment after removing compartment inner panel.

3. When draining system to prevent freezing, be sure and remove drain plug from air compressor cylinder head.

OPERATION

DIESEL ENGINE OPERATION

DIESEL ENGINE CONTROLS

Controls and gauges for operation of the Diesel engine from the driver's compartment are located in the gauge panel and switch panel (fig. 2). These are: Engine control switch, marked "CONTROL"; engine starter button, marked "START"; emergency stop button, marked "EMERG. STOP"; oil pressure gauge and low oil tell-tale; engine water temperature gauge and hot engine tell-tale; generator charge indicator; hand throttle.

Controls for operating engine from engine compartment at rear of vehicle are accessible through right-hand engine compartment door (fig. 6). These controls are: Engine starter button, marked "START"; engine stop button, marked "ENGINE STOP"; and starter cut-out switch, marked "OPEN WHEN WORKING ON ENGINE." Starter cut-out switch must be in "CLOSED" position when starting engine, either at front or rear.

MOTO-GARD AND TELL-TALE ALARM SYSTEM

Moto-gard and tell-tale alarm system comprises a group of automatic electrical devices which audibly and visually warn the driver that some abnormal condition exists which requires immediate attention. The following four conditions cause the alarm buzzer to sound:

1. Low oil pressure.
2. Overheated engine.
3. Low air pressure.
4. Emergency door open.

Tell-tale lights on drivers gauge panel will indicate which condition is causing the buzzer to sound. In addition to sounding buzzer and lighting tell-tale, the first two of the above conditions will also stop the engine by completing the circuit to the emergency stop solenoid, releasing the air choke valve. Low air pressure or open emergency door only light the tell-tale and sound the buzzer; they do not cause engine to stop. However, vehicle should not be moved when these tell-tales are illuminated.

In the event the moto-gard system stops the engine, it may be necessary to move the vehicle to safety. In case of such an emergency, a drum switch, which is connected to 1st, 2nd, and reverse shift lever at transmission, will break the circuit to the emergency stop solenoid when transmission is in 1st speed. This permits the driver to reset the air choke valve, start engine, and move vehicle to safety with transmission in 1st speed only. To start engine, reset air choke valve, then shift transmission into 1st speed, disengage clutch, and start engine. MOVE VEHICLE ONLY FAR ENOUGH TO REACH SAFETY. Transmission must remain in 1st speed while starting and running engine. Shifting into neutral or any other speed while the faulty condition still exists will immediately close the circuit to the emergency stop solenoid and the air choke valve will again close, stopping engine. Setting of air choke valve is explained below under "Emergency Stop Solenoid."

Note: Action of Moto-gard is not instantaneous. When alarm sounds and low oil or overheat tell-tale illuminates, time lag in action of Moto-gard permits driver to reduce speed and shift into 1st speed, which overrules Moto-gard circuit before the emergency stop solenoid is energized. Thus vehicle may be moved to safety without necessitating resetting the air choke valve. VEHICLE MUST BE STOPPED AS SOON AS POSSIBLE AND CAUSE OF ALARM CORRECTED.

EMERGENCY STOP SOLENOID

Engine emergency stop solenoid (fig. 5) is used as an emergency measure to stop engine in the event the engine fails to stop when "Engine Stop" button is pressed. Emergency stop solenoid is energized by pressing button marked "Emerg. Stop" on drivers gauge panel (fig. 2). Emergency stop solenoid is also energized by low oil pressure switch and by water overheat thermostat as pre-

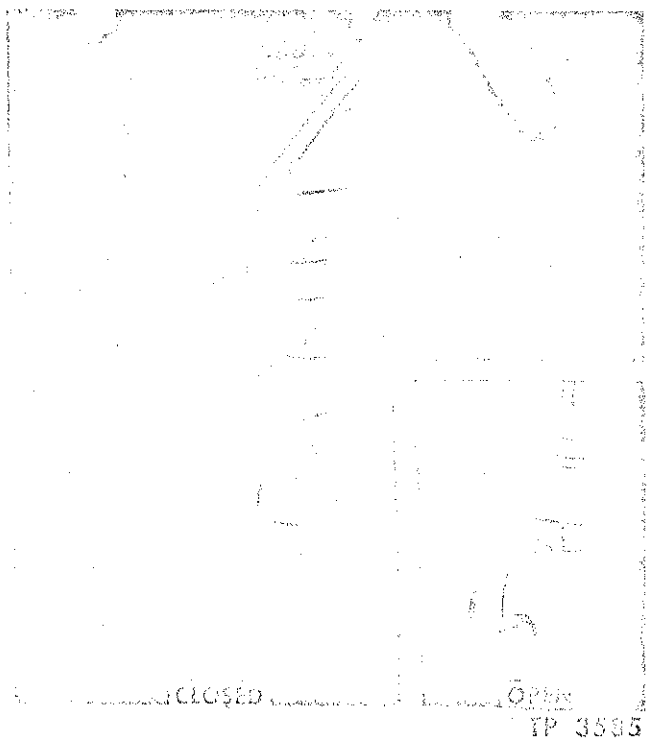


Figure 5—Emergency Stop Solenoid and Air Choke Valve Handle

OPERATION

viously explained under "Moto-Gard and Tell-tale Alarm System." Energizing the emergency stop solenoid pulls solenoid plunger away from release cam on air choke valve shaft, permitting air choke valve to close.

CAUTION: Whenever it has been necessary to press "Emerg. Stop" button to stop engine, do not restart engine until reason for loss of control is determined and corrected.

To reset air choke valve, turn release cam on valve shaft clockwise until shoulder on cam engages emergency stop solenoid plunger (fig. 5).

USE OF HAND THROTTLE

Hand throttle, located under lower right-hand corner of switch panel (fig. 1), is primarily for use in cold climates where low temperatures are prohibitive to stopping engine when vehicle is to remain standing for some length of time. As explained later in this section under "Idling Speed," Diesel engines have a tendency to cool off when running at a slow idle, causing incomplete combustion with its harmful effects on the engine. Also, running engine at idle speed for prolonged periods with lights, heaters, etc., turned on will cause excessive drain on battery. To maintain efficient engine operating temperature, and to maintain sufficient generator output to handle electrical load, set hand throttle to maintain necessary engine speed.

To set hand throttle, depress accelerator pedal to desired position, turn knob clockwise one-quarter turn and pull out just far enough to hold accelerator pedal in position, then turn knob counterclockwise one-quarter turn. Ratchet mechanism will hold throttle in the desired setting. To release hand throttle, turn knob clockwise one-quarter turn and push in.

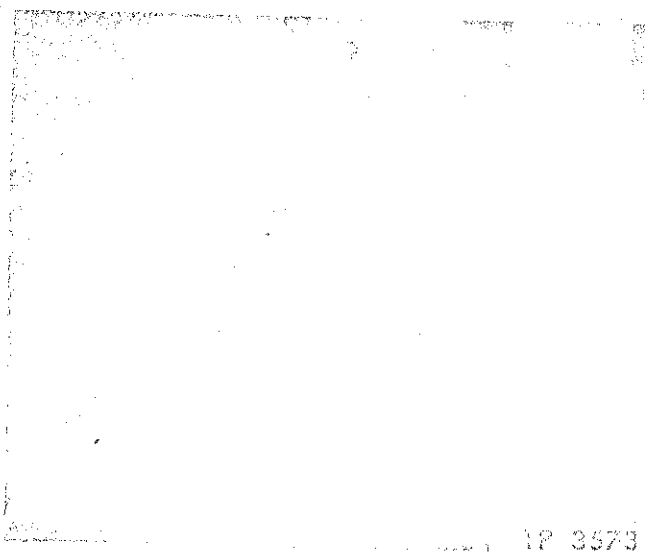


Figure 6—Engine Compartment Control Box

STARTING DIESEL ENGINE AT FRONT

1. With transmission shift lever in neutral position and hand brake lever in fully applied position, press accelerator pedal down as far as possible, then release pedal to move governor control lever from "no-fuel" to idling position.

2. Place engine control switch in "RUN" position to energize starter circuit. NOTE: When control switch is placed in run position, emergency door and low air pressure tell-tale alarm circuits are also energized; if vehicle has been standing for some time and air pressure is low, or of emergency door is open, buzzer will sound and tell-tale will illuminate. If "EMERG. DOOR" tell-tale lights, close emergency door. If "Low Air" tell-tale lights, continue with starting engine, but do not move vehicle until air-pressure has risen sufficiently to shut off tell-tale and buzzer.

3. Disengage clutch, then press "START" button to crank engine. Release button as soon as engine starts. CAUTION: Do not keep starter engaged longer than 10 to 15 seconds at a time. If engine fails to start, release start button and wait 10 to 15 seconds before again engaging starter. Repeat cycle as necessary; however, if engine fails to start in a reasonable length of time, determine and correct cause of failure.

4. Slowly release clutch pedal when engine starts, then observe gauges as explained later under "Diesel Engine Warm-up."

STARTING DIESEL ENGINE AT REAR

1. At front of vehicle, make sure transmission shift lever is in neutral position and that hand brake is fully applied. It is not necessary to place control switch in "Run" position before starting engine at rear.

2. Move governor from "no-fuel" to "idling" position by manually moving control lever (at top of governor) to center position in governor cam.

3. Make sure starter cut-out switch is in "CLOSED" position (fig. 6). Press and hold "START" button to crank engine. Release button as soon as engine starts. Use same precautions regarding use of starter as previously explained under "Starting Engine at Front."

FAILURE TO START

If engine fails to start, reference should be made to the various trouble shooting charts out-

lined in the "Diesel Engine Maintenance Manual," Form X-4517.

COLD WEATHER STARTING

Use of an air heater is recommended when starting of engine becomes a problem at lower atmospheric temperature. Refer to "Cold Weather Starting" in "General Information," Section 17, Diesel Engine Maintenance Manual (Form X-4517).

DIESEL ENGINE WARM-UP

It is recommended that the Diesel engine be permitted to go through a short warm-up period to permit driver to observe gauges and operation before engine is placed under load. During this warm-up period the following precautions and observations should be made.

IDLING SPEED

When starting a cold engine, increase engine speed to a fast idle (1/3 throttle - approximately 600 rpm) as soon as engine starts. Unlike conventional gasoline engines, Diesel engines have a tendency to get cold when running at a slow idle. Incomplete combustion in a cold, slow-idling Diesel engine causes formation of harmful deposits on engine parts, with possibly more serious damage resulting.

OIL PRESSURE

When the engine is first started, consistency of the oil may cause a slight rise in the pressure reading on the oil gauge. After engine warms up, the pressure should recede slowly to normal. Normal readings are: Idling - 4 pounds minimum; governed speed - 25 pounds minimum.

Oil pressure gauges, one in gauge panel and one on engine, do not indicate the quantity of oil in the crankcase. This may be determined only by a visual check of the crankcase dipstick as previously explained in this section under "Fuel, Oil, and Water."

Low oil pressure switch, mounted on left front side of engine, is electrically connected into the Moto-gard and tell-tale alarm system. Operation of this system is explained elsewhere in this section under "Moto-gard and Tell-tale Alarm System."

OPERATING TEMPERATURE

Efficient operating temperature of the GM Series 71 Diesel Engine is 160°F. to 185°F., (180°F. preferable). Maintain this temperature under all operating conditions. If conditions permit, avoid moving vehicle until thermo gauge indicates a coolant temperature of at least 140°F. However, idling for reasonable maneuvering, loading, or unloading is permissible. AVOID ALL UNNECESSARY IDLING. Stop engine when vehicle is to remain standing for any length of time. NOTE: When operating vehicle in cold climate, it may be undesirable to stop engine when vehicle is to remain standing. In this case, engine should be run at a fast idle as explained previously in this section under "Use of Hand Throttle."

GENERATOR CHARGING

Generator charge indicator on gauge panel (fig. 2) indicates three conditions.

1. With pointer in red segment on left-hand side, generating circuit is complete but generator is not supplying sufficient current to handle the electrical load and the battery is being discharged.
2. With pointer in red segment on right-hand side, generating circuit is open. This may be caused by a blown main fuse, engine control switch off, defective voltage regulator, or broken or defective wiring.
3. With pointer in cream (center) segment, generator is charging properly.

AIR PRESSURE

During the warm-up period, the air pressure should continue to build up to the compressor cut-out pressure (100-105 lbs.). Do not race a Diesel engine to pump up air pressure. Do not use over 1/3 throttle. No attempt should be made to move the vehicle until pressure is at least 70-75 lbs. These vehicles are equipped with a low air pressure alarm system. The buzzer will sound and tell-tale on gauge panel will illuminate when the air pressure drops between 54-66 lbs., and tell-tale will remain illuminated until pressure reaches this minimum.

DURING DIESEL ENGINE OPERATION

During operation of Diesel engine, the driver should observe the readings of the gauges. By these readings the driver can determine, in many instances, any abnormal symptoms which may affect the operation of the engine. In addition to observations of gauges and signals, there are some practices peculiar to Diesel engine which must be followed.

Most efficient and economical operation of engine will be obtained by maintaining engine speed of 1500 to 2000 rpm when operating vehicle under full load. Maintain engine speed by careful selection of transmission gears.

Lugging, that is, operating engine below 1500 rpm with throttle fully opened, or under any condition where black smoke can be noticed from exhaust, should be avoided.

OPERATION

USING DIESEL ENGINE AS A BRAKE

When descending grades, engine may be used as a brake in checking vehicle speed. Braking effect of engine increases with its speed. The maximum speed, however, must not exceed 2000 rpm. Engine running at governed speed will safely hold vehicle descending a grade in the same gear as is required to climb the same grade. There is no need to use the stop switch since the governor will automatically cut off the fuel supply whenever the accelerator is released to idling position and the engine speed is above 400 rpm.

OBSERVATION OF GAUGES AND SIGNALS

Operating Temperature. As previously stated under "Engine Warm-up," efficient engine operating temperature is 160°F. - 185°F. (preferably 180°F). If temperature suddenly approaches 212°F., stop vehicle and determine cause of high temperature and make necessary corrections. When temperature reaches 212°F., engine overheat thermostat closes circuit which actuates Moto-gard and tell-tale alarm system and engine will automatically stop. Operation of this system is explained elsewhere in this section under "Moto-gard and Tell-tale Alarm System." By stopping vehicle and correcting cause of high temperature before the temperature reaches 212°F., the inconvenience occasioned by the emergency stop is eleminated.

Oil Pressure. Immediately stop engine if oil pressure gauge shows an abnormally low reading. Determine cause of low oil pressure and make necessary correction. If oil pressure drops below 3 pounds, low oil pressure switch contacts close, actuating Moto-gard and tell-tale alarm system, automatically stopping engine. Operation of this system is explained elsewhere in this section under "Moto-gard and Tell-tale Alarm System."

Air Pressure. Immediately stop vehicle and determine cause of consistently low air pressure, or if buzzer sounds and low air pressure tell-tale illuminates.

Generator Charging. Generator charge indicator points should remain in cream (center) segment during normal operation. Pointer in red segment at left indicates that battery is being discharged. Pointer in red segment at right indicates open generating circuit. This may be caused by blown main fuse, engine control in off position, defective voltage regulator, or defective wiring. Stop vehicle, and locate and correct cause of open circuit.

STOPPING ENGINE

AT FRONT

Set hand brake lever in fully applied position. Shift transmission into neutral or keep clutch disengaged until engine stops. It is a good practice to permit engine to idle for approximately 30 seconds before stopping. Place control switch on switch panel (fig. 2) in "STOP" position. It is not necessary to hold switch in "STOP" position until engine stops.

If engine fails to stop, press "EMERG. STOP" button on gauge panel (fig. 2). Whenever "EMERG. STOP" button is used to stop engine, air choke valve in blower air intake must be re-set manually before engine can be started (fig. 5). CAUTION: Do not re-start engine until reason for loss of control is determined and corrected. To re-set choke valve, swing handle up to horizontal (open) position (fig. 5).

AT REAR

Press "ENGINE STOP" button on control box in engine compartment (fig. 6). In the event engine fails to stop, raise emergency stop solenoid plunger (fig. 5) manually to release air choke valve. Whenever emergency stop has been used, air choke valve must be re-set as described in preceding paragraph.

USE OF TRANSMISSIONS

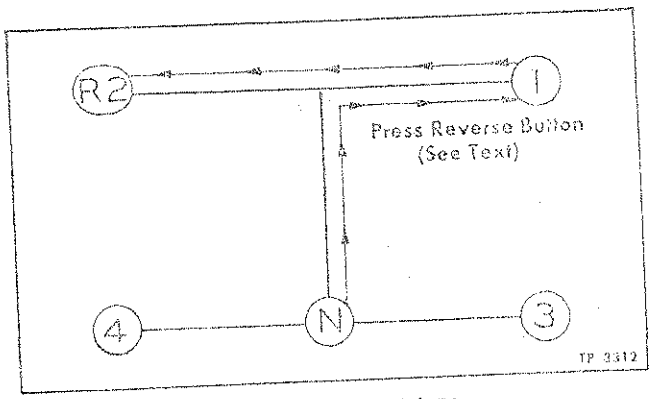


Figure 7—Transmission Shift Diagram

Transmission has four forward speeds and one reverse. Shift lever positions are illustrated in figure 7. Reverse shift pattern is indicated by arrows in figure 7.

GENERAL CAUTIONS

Avoid Clashing Gears - serious damage can result.

Do not Shift Into Reverse when vehicle is moving forward.

Do not Shift Into Any Forward Speed when vehicle is moving backward.

Shift Into Next Lower Gear BEFORE engine begins to labor, when ascending grades, or in snow, etc

LOW TO HIGH SHIFTING

Double-clutching method is recommended when shifting from 1st to higher gears. Progressively shift from 1st to 4th - do not skip speeds. Do not attempt to shift into next higher speed until sufficient road speed has been attained.

HIGH TO LOW SHIFTING

Always shift into the next lower gear before engine begins to labor. Make use of the lower gears when ascending or descending a grade, in snow, mud, or off-the-road service. Always progressively shift into lower gears. Do not skip speeds. Always use double-clutching method when shifting from high to low speeds.

REVERSING

The engine control switch must be in "RUN" position to energize the reverse shift solenoid circuit before the transmission can be shifted into reverse position. Shift into reverse is made as follows:

1. With vehicle at a complete stop and clutch pedal depressed, move shift lever from neutral (N) to 1st (fig. 7).

2. Press "REVERSE SHIFT" button at left of gauge panel (fig. 2). While holding button in, shift lever into "R2" position (fig. 7).

3. Transmission is now in reverse gear, and vehicle can be backed by releasing clutch pedal slowly and simultaneously depressing accelerator pedal.

To shift from reverse to neutral, the following procedure must be used:

1. With vehicle at a complete stop, depress clutch pedal.

2. Move shift lever from reverse to 1st speed position, then into neutral. It is not necessary to push "REVERSE SHIFT" button when shifting out of reverse.

NOTE: After moving shift lever from reverse position, lever must always be moved to 1st speed position before shifting to other forward speeds.

USE OF BRAKES

Brakes are applied by depressing the brake treadle, located on toeboard to the left of the accelerator pedal (fig. 1). Varying degrees of brake application are obtained by varying the distance the treadle is depressed. From a driver's viewpoint, operation of brakes on an air brake equipped vehicle is only slightly different than on a vehicle equipped with conventional hydraulic or mechanical brakes. The following brief operating instructions should familiarize the driver with operation of air brakes.

AIR PRESSURE

Before moving the vehicle, observe air pressure registered on air pressure gauge. Reservoir pressure must be at least 70 to 75 pounds before air brakes can develop their full effectiveness. Observe this pressure frequently while vehicle is in motion. If at any time the air pressure drops below 75 pounds, stop the vehicle immediately. These vehicles are equipped with a low air pressure alarm system. When air pressure drops below 66-54 lbs., buzzer will sound and "LOW AIR" tell-tale on gauge panel (fig. 2) will illuminate. Stop vehicle immediately when alarm sounds, and locate and correct cause of pressure loss before moving vehicle.

APPLYING BRAKES

Best braking effect will be obtained by making original brake application as hard as speed and road conditions permit, then reducing application pressure gradually as speed is reduced so that at end of stop only a slight pressure remains in brake chambers. Do not first apply brakes lightly, then increase application pressure as speed decreases. This not only requires more time for a stop, but the final high pressure will produce a severe final stop.

Do not "fan" the brake treadle. This causes poor brake performance, wastes air pressure, and causes excessive wear on brake operating units and brake lining. "Fanning" does not increase brake line pressure, but decreases both reservoir and line pressure.

When brake pedal is depressed, stop light switch functions to light stop lights. Tell-tale marked "STOP LAMP" on gauge panel (fig. 2) will illuminate when stop lights are on. Failure of tell-tale to illuminate when brakes are applied indicates burned out stop light bulbs or a blown stop light circuit fuse.

USE OF HAND BRAKE

Hand brake is applied by hand brake lever at left of driver. As a safety measure, always apply hand brake whenever vehicle is parked, and whenever driver leaves vehicle.

Hand brake can be used to stop vehicle in the event of failure of service brakes. However, relatively small area of braking surface will require a much longer distance to stop vehicle than that required when using service brakes. Hand brake should never be used to stop vehicle except in case of emergency.

OPERATION

USE OF LIGHTS

All internal and external lights, with the exception of engine compartment lights and stop light, are controlled by switches in the driver's compartment. The engine compartment lights are controlled by a switch mounted in engine compartment control panel. Stop light is controlled by an air operated switch connected into brake system. In some instances, light switches on switch panel (fig. 2) control several lights in addition to the lights indicated on switch panel. Each switch and the lights which it controls is listed below under "Light Switches."

LIGHT SWITCHES

HEAD

Switch controls circuit to headlights, dimmer switch, and high beam tell-tale.

FOG

Switch controls circuit to fog lights. Lights are turned on and off by foot switch (fig. 1).

MARKER - FRONT

Switch controls circuit to front marker lights.

MARKER - REAR

In addition to controlling rear marker lights, this switch controls circuit to panel lights, tail-lights, target sign lights, and reading lights. Reading lights are turned on and off by individual switches. The first four of these light circuits are protected by the same fuse; reading lights are divided into two circuits, each circuit being protected by a separate fuse.

M. MARKER - FRONT AND REAR

Two switch controls circuit to front and rear Michigan marker lights.

CLEAR

Switch controls circuit to side clearance lights (when used). Switch is ineffective on vehicles not equipped with side clearance lights.

SIGN

In addition to controlling circuit to front destination sign lights (and side destination, when used), this switch controls circuit to front emblem light and night lights. All of these circuits are protected by a single fuse.

GENERAL LIGHTING

Two switches control circuits to dome lights above passenger seats. These lights permit driver to light up interior of coach when all reading lights are turned off by individual switches.

INDIRECT LIGHTING

Two switches control circuits to indirect lights in upper edge of package rack rails.

BAGGAGE

Switch controls circuit to all baggage compartment lights. Light in each compartment is turned on and off by individual switches.

STEP

Switch controls circuit to step lights. Lights are automatically turned on and off by a switch operated by door control linkage.

DRIVER'S LIGHT SWITCH

Driver's light switch is located at driver's light on trim panel above driver's window.

SPOT LIGHT SWITCH

Spot light switch is located on spot light control handle.

EXTERIOR LIGHTS

HEADLIGHTS

Headlights are controlled by a push-pull type switch on switch panel, marked "HEAD" (fig. 2). After switch is pulled out, high and low beams are selected by use of dimmer switch on floor (fig. 1). High beam is generally used for highway operation. Low beam is used when approaching another vehicle or for city driving. Tell-tale at top of gauge panel marked "HIGH BEAM" (fig. 2) illuminates when high beam is selected.

FOG LIGHTS

Fog light circuit is energized when switch marked "FOG" (fig. 2) is pulled out. Fog lights can then be turned on or off by fog light foot switch on floor (fig. 1).

DIRECTIONAL SIGNAL LIGHTS

Directional signal lights are controlled by lever type switch on side of gearshift and steering gear housing (fig. 1). Pulling lever up turns on left-hand front and rear signal lights; pressing lever down turns on right-hand front and rear signal lights. Tell-tale on switch housing flashes on and off when either right or left-hand signal lights are illuminated.

DESTINATION SIGN LIGHTS

Front destination sign lights (and side destination sign when used) are turned on when switch marked "SIGN" (fig. 2) is pulled out. This switch also turns on front emblem light and interior night lights.

MICHIGAN MARKER LIGHTS

Front and rear Michigan marker lights are turned on when two switches marked "M. MARKER" (fig. 2) are pulled out. Michigan marker lights are the three lights at top center of vehicle, front and rear.

MARKER LIGHTS

Marker lights at each top corner of vehicle are controlled by two switches marked "MARKER" (fig. 2). Rear marker light switch also turns on panel lights, taillights, target sign lights, and energizes circuit to passenger reading lights. Reading lights are turned on and off by individual switches at the lights.

TAILLIGHTS

Taillights are illuminated when switch marked "MARKER-REAR" (fig. 2) is pulled out.

SPOT LIGHT

Spot light is turned on and off by switch on spot light control handle (fig. 1).

FRONT EMBLEM LIGHT

Front emblem light is turned on when switch marked "SIGN" (fig. 2) is pulled out.

CLEARANCE LIGHTS

Side clearance lights, when used, are turned on when switch marked "CLEAR" (fig. 2) is pulled out. This switch is ineffective when vehicle is not equipped with side clearance lights.

STOP LIGHTS

Stop lights at each rear corner and in target sign are illuminated by action of air operated switch when brakes are applied. Tell-tale on gauge panel marked "STOP LAMP" (fig. 2) illuminates when stop lights are on. Failure of tell-tale to illuminate when brakes are applied indicates burned out stop light bulb or fuse, or other trouble in the stop light circuit.

INTERIOR LIGHTS

DRIVER'S LIGHT

Driver's light, on trim panel above driver's window, is turned on and off by a switch at the light.

NIGHT LIGHTS

Blue night lights, near rear of vehicle, are illuminated when switch marked "SIGN" (fig. 2) is pulled out.

INDIRECT LIGHTS

Indirect lights, in top edge of package rack rails, are turned on and off by two switches marked "INDIRECT" (fig. 2).

READING LIGHTS

Reading light circuit is energized when switch marked "MARKER-REAR" (fig. 2) is pulled out. Each light is turned on and off by individual switches at lights.

GENERAL LIGHTS

General lights, one above each pair of seats, are turned on and off by switches marked "GENERAL" (fig. 2). These lights permit driver to light up interior of coach when all reading lights are turned off by individual switches.

PANEL LIGHTS

Panel lights illuminate driver's gauge panel when switch marked "MARKER-REAR" (fig. 2) is pulled out.

STEP LIGHTS

Step light circuit is energized when switch marked "STEP" (fig. 2) is pulled out. Lights are automatically turned on and off when door is opened and closed.

COMPARTMENT LIGHTS

BAGGAGE COMPARTMENT LIGHTS

Baggage compartment lights are turned on and off by individual switches in the compartments after switch marked "BAGGAGE" (fig. 2) is pulled out. Switches in compartments are automatically turned on and off by opening and closing of baggage compartment doors.

ENGINE COMPARTMENT LIGHTS

Engine compartment lights are turned on and off by switch marked "COMP'T LAMPS" on engine compartment control box (fig. 6).

TELL-TALE LIGHTS

Tell-tale lights located in driver's gauge panel (fig. 2) are barely visible except when light is illuminated. Purpose of each tell-tale is explained below.

HOT ENGINE, LOW OIL, LOW AIR, AND EMERGENCY DOOR TELL-TALE LIGHTS

These tell-tales, located at bottom of driver's gauge panel (fig. 2) operate in conjunction with Moto-gard and tell-tale alarm system. Operation of this system is explained elsewhere in this section under "Moto-gard and Tell-tale Alarm System."

STOP LAMP TELL-TALE LIGHT

Stop lamp tell-tale light illuminates when brakes are applied to assure driver that stop lights are illuminated. Failure of tell-tale to illuminate when

brakes are applied serves to warn driver that stop lights are not illuminated.

HIGH BEAM TELL-TALE LIGHT

High beam tell-tale serves to aid driver in selecting headlight high and low beams with foot dimmer switch. Tell-tale is illuminated when headlight high beam is selected.

DIRECTIONAL SIGNAL TELL-TALE LIGHT

Directional signal tell-tale light on right-hand side of steering gear and gearshift housing flashes on and off when either right or left directional signals are on. This assures driver that directional signals are working properly, and also serves to remind driver to turn signals off when turn is completed.

DOOR AND RETRACTABLE STEP

Passenger entrance and exit door is manually operated by the door control lever, located on windshield ledge (fig. 1). Door can be opened independently or in conjunction with retractable step.

To open door without lowering step, lift up on door control handle, then swing handle in a counterclockwise direction. Push handle around as far as possible to lock door in open position.

To lower retractable step simultaneously with opening of door, press down on door control handle before opening door.

Door can be opened from outside vehicle by pressing release button extending through front body panel above front license compartment (fig. 3). Pressing release button unlocks door mechanism, permitting door to be pulled open.

In the event damage to step prevents closing door, step can be easily removed as directed in Body (Sec. 3B of this manual).

WINDOWS

SIDE WINDOWS

Emergency Escape

Side window sash are hinged at bottom to provide passenger escape under emergency conditions. Sash is held in closed position by spring-loaded latches at top. A strong push against top of window overcomes latch springs and causes window to swing outward and downward against body side. CAUTION: Windows should be opened in this manner only in case of emergency, since damage to body, sash frame, or glass usually results.

Ventilation

Side windows can be opened for ventilation in event of failure of air-conditioning unit. Each window regulator must be individually unlocked with driver's key. Rear of window can then be opened outward approximately 1-1/2 inches.

ENTRANCE DOOR AND DRIVER'S WINDOWS

Entrance door and driver's windows can be lowered and raised by conventional crank-type window regulators.

SPARE WHEEL AND TIRE

REMOVAL

1. Remove cap nuts from two tire compartment door studs (fig. 8). Swing bumper and tire compartment door downward.

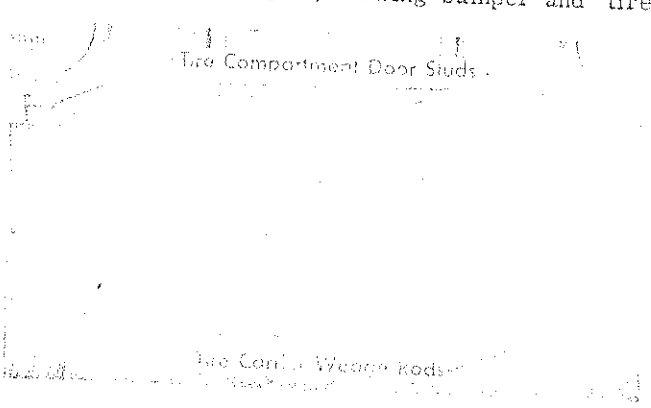


Figure 8—Spare Tire Compartment

2. Turn tire carrier lock bar one-quarter turn and pull bar out from between tire carrier and bottom of compartment.

3. Using door lock wrench, turn tire carrier wedge rods counterclockwise to lower carrier onto rollers. Grasp carrier at each side and pull out.

4. Remove spare tire hold-down nut and bar. Remove wheel and tire from carrier.

INSTALLATION

1. Place wheel and tire on carrier with valve stem pointing downward. Valve stem should be toward front of vehicle to permit gauging or inflation through access door in bottom of compartment.

2. Attach wheel and tire to carrier with hold-down bar and nut.

3. Lift carrier and push into compartment. Using door lock wrench, turn tire carrier wedge rods clockwise to lift carrier up off rollers.

4. Push tire carrier lock bar in between carrier and bottom of compartment, then turn bar on edge as shown in figure 8.

5. Swing door and bumper up, install cap nuts on studs, and tighten securely.

BATTERY CABLE CONNECTOR BLOCK

Battery cable connector block (fig. 9) is accessible through door immediately ahead of left rear wheel. Connector block is so designed that battery cables may be quickly disconnected in the event a short in the electrical system necessitates such action. To disconnect cables, press retainer bar latch to left; spring loaded retainer bar will fly open and cables can be pulled out of notches in block.

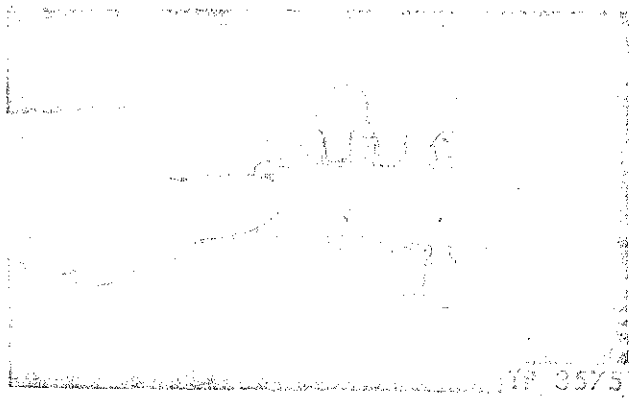


Figure 9—Battery Cable Connector Block

HEATING AND VENTILATION

The heating and ventilation operating instructions shown in succeeding paragraphs describe only the standard heating and ventilating systems. These instructions do not include any operation of Air Conditioning Units. Instructions on Air Conditioning may be obtained from the manufacturer of that equipment.

VENTILATION

Coach is ventilated by motor driven blowers, which operate efficiently only with all windows closed. In event of failure of ventilating system, windows can be opened as described earlier in this section.

MAIN BLOWER CONTROL

Main ventilator blowers are controlled by "Ventilation" switch at lower right corner of driver's switch panel (fig. 2). Under normal operating conditions (except when cooling is desired) switch lever should be moved up to "Ventilation" position while coach is in operation. Main blower also operates with switch in "Cooling" position.

FRESH AIR BLOWER CONTROL

Fresh air intake blowers are also controlled by "Ventilation" switch on standard system. Intake blowers operate with switch in either "Ventilation" or "Cooling" positions. Intake blowers may be turned off, with switch in "Ventilation" position, by pulling "Fresh Air Blower Cutout" switch (fig. 2). This is a momentary switch and returns to off position when released. However, momentary closing of switch prevents operation of intake blowers until position of "Ventilation" switch is changed. With "Ventilation" switch in "Cooling" position, "Fresh Air Blower Cutout" switch is ineffective.

On Special (N.Y.) system, fresh air intake blowers are connected to coach engine generator circuit, and operate whenever generator is charging regardless of "Ventilation" switch position. "Fresh Air Blower Cutout" switch is not connected, and consequently is inoperative in this system.

HEATING

Vehicle is warmed by a single heating radiator in air duct in front baggage compartment. Heating radiator is supplied with hot water from vehicle engine.

Heating is entirely automatic, the driver having no direct control of this function. In the event coach becomes excessively warm due to failure of heating radiator thermostat, heat can be shut off by closing valve in heater supply line in engine compartment.

OPERATION

DEFROSTING

Deflectors at top of each windshield section are connected to vehicle air ducts and convey conditioned air to windshield for normal defrosting. Additional defrosting is provided by a fan mounted in each vertical duct at rear of entrance door and driver's window. Fans, mounted behind adjustable grilles in front of vertical ducts, are controlled by "Defr." swtich in switch panel (fig. 2). Grille shutters may be opened or closed, as desired, by knob at side of grille.

TELL-TALES

Three "Air Conditioning" tell-tale lights are mounted on driver's switch panel between "Control" switch and "Cooling Start" button (fig. 2). Wording is visible only when tell-tales are illuminated.

Tell-tales are used in connection with air cooling unit, and instructions may be obtained from manufacturer of the cooling equipment.

Since two of the tell-tales may be lighted even when air conditioning unit is omitted, following is a brief description of their operation:

1. "Stop Eng." tell-tale is operative only with air conditioning unit installed.
2. "Turn On" tell-tale circuit is energized in "Run" position of "Control" switch. Thermostat, on left-hand vertical air duct, lights tell-tale when coach interior temperature rises to (exceeds) 76°F.
3. "Turn Off" tell-tale circuit is energized in "Cooling" position of "Ventilation" switch. Thermostat, is left-hand fresh air duct, light tell-tale when temperature of incoming fresh air falls to 55°F.

Front End Alignment

Contents of This Section

Related Subjects in Other Sections

Front end alignment chart, shown in figure 1, illustrates the various points from which front end alignment dimensions are taken.

Reference should be made to "Wheel Alignment Dimensions," at end of this section, for correct alignment data pertaining to particular model being checked. Refer to Trouble Shooting (Sec. 21 of this manual) for alignment trouble symptoms causes, and probable remedies.

Proper alignment of front wheels must be maintained in order to insure ease of steering and satisfactory tire life. The most important factors of front wheel alignment are: wheel camber, axle caster and wheel toe-in, which are described briefly in succeeding paragraphs.

These points should be checked at regular intervals, particularly where front axle has been subjected to heavy impacts due to collision or hard curb bumps

When checking wheel alignment, it is important that wheel bearings and steering knuckle bearings be in proper adjustment. Loose bearings will affect reading of instruments when checking camber, king pin inclination, and wheel toe-in.

When performing front end alignment check, instructions relating to front end alignment, outlined in this section, should be carefully followed as well as instructions covering other related units such as steering gear, brakes, springs, hubs and bearings, wheels, and tire inflation. These related instructions can be found in their respective sections. Refer to index above.

Adherence to alignment data, listed in "Wheel Alignment Dimensions" at end of this section, is strongly recommended. Precision equipment and instruments should be made available for accurate check-up and corrective work. Refer to figure 1 frequently when checking front end alignment.

FRONT END ALIGNMENT FACTORS

Front end alignment factors discussed in this group include: FRONT WHEEL TOE-IN, FRONT WHEEL CAMBER, AXLE CASTER, KING PIN INCLINATION, AND STEERING GEOMETRY. These terms may be defined, briefly, as follows:

Wheel Toe-in - Distance front wheels are closer together at front than at rear of axle (See "J" and "H" on chart).

Wheel Camber - or Pitch - The amount of wheel inclination from a vertical position.

Positive Camber - Outward inclination of wheels at top (See "C" on Chart).

Zero Camber - No inclination - wheels are held in vertical plane.

Negative or Reverse Camber - Inward inclination of wheels at top.

Front Axle Caster - Inclination of king pin from the vertical in the fore and aft direction of the vehicle.

Positive Caster - Inclination of king pins toward rear of vehicle (See "N" on Chart).

Zero Caster - King pins are held in a vertical position.

Negative or Reverse Caster - Inclination of king pins toward front of vehicle.

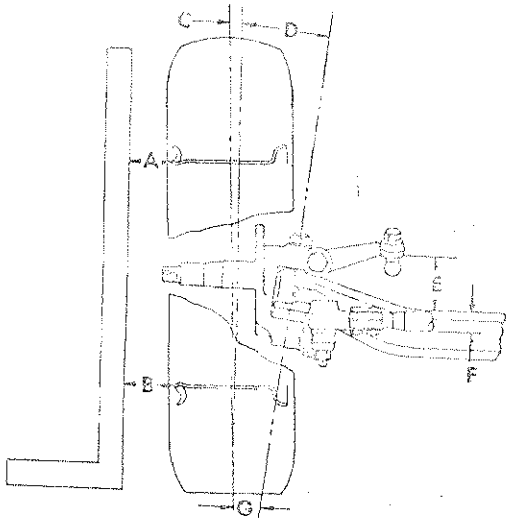
King Pin Inclination - The slant of the king pin toward the center of the vehicle at the top, and outward at the bottom. (See "D" on Chart).

Steering Geometry - The mechanics of keeping front wheels in proper relative alignment as wheels are turned to extreme right or left.

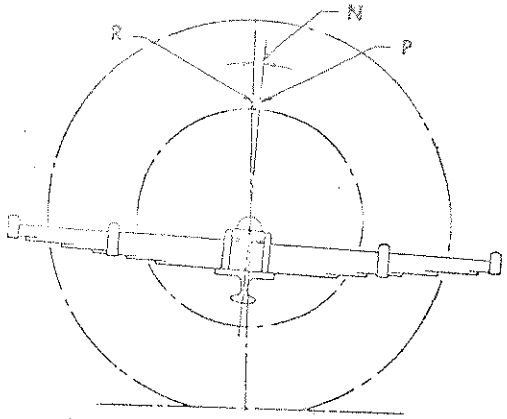
FRONT WHEEL TOE-IN

The purpose of toe-in is to offset the effect of camber, thus preventing side slipage and cross wear of tires. Since camber and toe-in bear a definite relation to each other, both should be

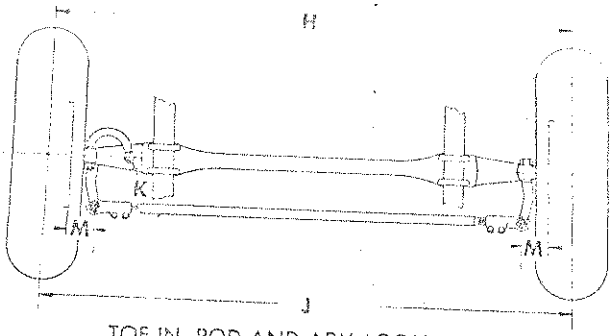
FRONT END ALIGNMENT



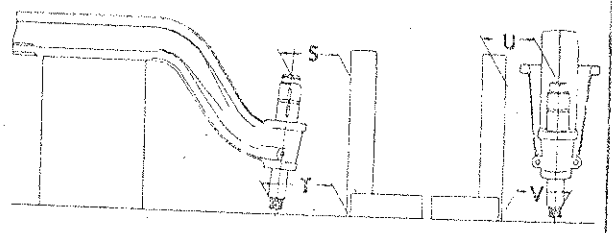
CAMBER, PIN INCLINATION, ARM AND ROD LOCATIONS



FRONT AXLE CASTER



TOE-IN, ROD AND ARM LOCATIONS



AXLE CENTER TWIST AND PIN INCLINATION

B Minus A ..... Camber (Inches)
C ..... Camber (Degrees)
D ..... King Pin Inclination
E ..... Bottom of Steering Arm Above Axle
F ..... Bottom of Tie Rod Below Spring Seat
G ..... Tire Overhang
J Minus H ..... Toe-in

K ..... Relation of Steering Arm to Center of Axle
M ..... C/L of Tie Rod End to Wheel Rim
N ..... Caster Angle
P ..... C/L of King Pin
R ..... Vertical
T Minus S ..... I-Beam Twist
U Minus V ..... King Pin Inclination

Refer to "Wheel Alignment Dimensions" for Numerical Values.

TP 3094

Figure 1—Front End Alignment Chart

checked at the same time.

Where maximum allowable camber exists, wheels should be adjusted for maximum allowable toe-in.

Toe-in is usually measured from centers of tire treads at height of wheel centers (See "J" and "H" on chart). However, toe-in readings can only be obtained accurately with instruments designed for that purpose. Toe-in should always be measured with wheels in straight ahead position.

Before checking toe-in and camber, check wheels for correct installation and check tires for correct air pressure. Wheel installation and tire inflation have a definite bearing on toe-in and camber.

Refer to Wheels and Tires (Sec. 19B of this manual) for instructions pertaining to these items.

If instrument readings indicate necessity of toe-in adjustment, toe-in should be adjusted as directed under "Front Wheel Toe-in Adjustment" in Front Axle (Sec. 1B of this manual).

FRONT END ALIGN

FRONT WHEEL CAMBER

The purpose of camber (See "C" on Chart) is to offset deflection and wear of front axle parts, thus preventing wheels from going into REVERSE camber after long service.

The result of excessive POSITIVE camber is irregular wear of tires on outside shoulders. Excessive positive camber is usually caused by bent parts.

The result of excessive NEGATIVE camber, will be hard steering and possibly a wandering condition. Tires will also wear on inside shoulders. Negative camber is usually caused by excessive wear or looseness of front wheel bearings and steering knuckle bushings, or may be the result of sagging axle. A SAGGING AXLE MAY BE CAUSED BY USE OF HEAT WHEN STRAIGHTENING AXLE CENTER.

The result of UNEQUAL camber may be any or a combination of following conditions: Unstable steering, wandering, kick-back or road shock shimmy, or excessive tire wear. The cause of unequal camber is usually a bent steering knuckle or axle center.

CHECKING CAMBER

Before checking camber, the vehicle should be jacked up at front axle for inspection of wheel bearings and king pins. Excessive looseness of king pins may be checked with a camber gauge attached to wheel. Pull outward at bottom of wheel to take up all slack in wheel bearings and king pins, then take a camber reading. Pull outward at top of wheel and take another reading. If the difference between the two readings exceeds $1/4^{\circ}$, make following adjustments and checks.

1. Adjust wheel bearings as described in Hubs and Bearings (Sec. 19A of this manual) then take another camber reading as described in preceding paragraphs. If difference is more than $1/4^{\circ}$, replace steering knuckle bushings and king pins.

2. Check run-out of wheel at rim in manner described in Wheels and Tires (Sec. 19B of this manual). If run-out or wobble is excessive, straighten or replace wheel.

3. Vehicle should be placed on level floor with full weight on wheels to make final camber reading. It is recommended that an accurate camber gauge be used, however, if a camber gauge is not available, readings can be taken as illustrated at "A" and "B" on chart. Place square as shown and measure distance between "A" and rim, and "B" and rim. Lower dimension should exceed upper dimension by amount listed in "Wheel Alignment Dimensions" at end of this section. This dimension on right wheel should not vary over 3/32 from same dimension of left wheel.

4. CAMBER ERROR - An error in final camber reading usually indicates a bent axle center or steering knuckle.

5. To determine whether steering knuckle axle center is bent, the KING PIN INCLINATION ("D") should be checked. By adding camber to king pin inclination ("C" plus "D"), the INCLUDED ANGLE of steering knuckle is obtained. If there is a difference of $1/2^{\circ}$ between the included angle of left knuckle and right knuckle, replace the knuckle which is bent.

AXLE CASTER

The purpose of caster (See "N" on Chart) is to provide steering stability which will keep front wheels in a straight ahead position and to assist in bringing wheels out of a turn or curve. When checking caster, it is desired to have not more than 1/2 degree difference between right and left wheels.

The result of NEGATIVE caster is wandering or the vehicle will not come out of turn normally. The cause of negative caster may be sagging or dislocated springs or bent axle center.

Excessive POSITIVE caster will cause front wheel shimmy and will also cause hard steering. Uneven tightening of spring U-bolt nuts will definitely affect caster. Tighten all U-bolt nuts equally and with same degree of effort.

KING PIN INCLINATION

King pins are inclined (See "D" on Chart) to decrease frictional resistance of tires against the road when turning to right or left. Special precision instruments should be used to check king pin inclination; however, a check can be made on bench as shown in chart.

Install king pin bushing on king pin, then rest spring seats on blocks as shown in figure 1. Make check on perfectly level surface. Use square at both ends as shown and measure distance from both ends of king pin (from bushing at upper end) and vertical edge of square (See "V" and "U" on chart). Difference between "U" dimension and "V" dimension is king pin inclination, in inches, and should be same as shown in "Wheel Alignment Dimensions" at end of this section. Axle center twist can also be checked as shown at "S" and "T" on chart.

STEERING GEOMETRY

Steering geometry is the mechanics of keeping front wheels in proper relative alignment as the wheels are turned to extreme right or left. It is sometimes called steering error or steering angularity. The governing factors in steering geometry are the length and angularity of the steering arms and linkage. As a greater part of all driving is done on angle of turns, steering geometry becomes one of the most important factors of front wheel alignment.

Steering error in combination with excessive

FRONT END ALIGNMENT

camber is, briefly, the cause of uneven tire wear. Elimination of this error reduces tendency to skid on turns, eliminates excessive strain on front wheels in turning, improves steering, and decreases tire wear.

It is recommended that special equipment be used to check for steering geometry error.

The following points to check in addition to those previously described are: (See Chart).

1. Relative position of drag link arm to axle spring seat, "E" on chart.
2. Relative position of tie rod to spring seat, "F" on chart.
3. Relative position of steering arm to center line of axle center, "K" on chart.
4. Relative position of tie rod ends to flange plate rim, "M" on chart.

SPECIAL TOOLS

Reference is made to special tools in this section. These tools, or their equivalent, are necessary and are recommended to more readily and efficiently accomplish certain service operations. The tools, however, are not supplied by GMC Truck & Coach Division. Names and addresses of vendors or manufacturers are shown as a reference, and since such vendors are the suppliers of these tools, information regarding availability, price, etc., should be obtained directly from them.

Name	Tool No.
Micro-Liner Set (Wheel Alignment)	TA-1056
Super - Easy Caster Camber Gauge Set	SE-1234

Vendor	Address
Testing Apparatus Company	Detroit, Michigan

WHEEL ALIGNMENT DIMENSIONS

(Refer to Alignment Chart)

B - A = Camber (Inches	3/8 in.
C = Camber (Loose Axle)	$1^{\circ} \pm 1/4^{\circ}$
C = Camber (Axle Installed)	$1/2^{\circ}$
D = King Pin Inclination	5° 30'
E = Drag Link Arm Above Spring Seat	2-3/16 in.
F = Top of Tie Rod Below Spring Seat	1-5/8 in.
J - H = Toe-in	3/16 to 1/4 in.
K = Relation of Drag Link Arm to Axle Center	On Center Line
L = Center of Drag Link Arm to Spring Edge	2-5/8 in.
M = Center of Tie Rod Ball to Flange Plate	1-7/8 in.
N = Caster Angle	1° 35' $\pm 1/2^{\circ}$ (See Text)
T - S = I Beam Twist	Equal
U - V = Pin Inclination	1-3/32 in.

Front Axle

Contents of This Section

Related Subjects in Other Sections

Front axle assembly used on this vehicle is Reverse Elliott type. Front axle I-beam, steering knuckles and steering knuckle arms are steel drop forgings heat treated to provide extreme toughness and resistance to bending and twisting strains. Wheel bearings and brakes which are carried on front axle are described in their relative sections of this manual. See "Index" above.

Specifications and service data on front axle and associated parts are listed in "Specifications" at end of this section. These limits and specifications should be adhered to whenever periodic inspections or maintenance operations are necessary.

STEERING KNUCKLES, KING PINS, AND BUSHINGS

Steering knuckles are provided with large thrust bearings between steering knuckle lower yoke and lower face of front axle I-beam, as shown in figure 1. Since these thrust bearings take vertical thrust loads, up and down movement of steering knuckle on axle center must be kept within proper limits to prevent pounding and consequent breakage of thrust bearings. Use of shims for correcting excessive up and down movement is described later under "Steering Knuckle Installation" in this section.

KING PINS

Tapered king pins are used on all vehicles covered by this manual. Center portion of king pin is tapered to correspond with taper of king pin hole in end of axle center. King pins are retained in steering knuckles with a nut locked in place with a cotter pin. When retaining nut is drawn up tight, tapered portion of king pin mates with taper of hole in axle center thus holding king pin rigidly in axle center.

STEERING KNUCKLE BUSHINGS

As illustrated in figure 1, bushings are used at upper and lower ends of steering knuckles. These bushings are line reamed after assembly to dimensions as listed in "Specifications" at end of this section. Bushings are sealed at upper ends of knuckles by seals held in place with steel retainers. Retainers are held in place by king pin nut. Seal and retainer at lower end of steering knuckle are held in place with a snap ring which fits into groove in king pin.

Horizontal and diagonal oil grooves have been machined into inside surface of steering knuckle bushings. These oil grooves index with lubrication fitting hole in bushings, thus insuring thorough lubrication of king pin and steering knuckle.

STEERING KNUCKLE REMOVAL (Fig. 1)

The steering knuckles may be removed from front axle without removing front axle assembly from the vehicle. Before removing the steering knuckles, perform a front end alignment check and other service inspections to determine repairs to be made. Remove steering knuckles from axle in the following manner:

1. Loosen wheel stud nuts then raise front of vehicle with jack.

2. Remove front wheels, then remove hubs and bearings as directed, under "Front Hub and

FRONT AXLE

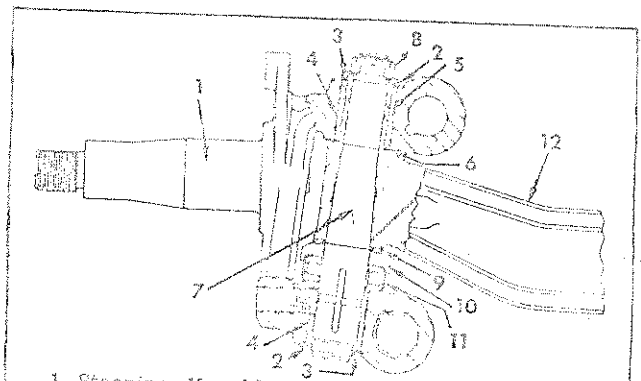


Figure 1—Steering Knuckle Sectional View

Bearing Removal", in Hubs and Bearings (Sec. 19A, of this manual).

3. Remove front brake shoes as directed under "Front Brake Shoe Removal" in Air Brakes (Sec. 4B, of this manual).

4. Remove nuts and lockwashers from studs which attach brake spider to steering knuckle, then remove brake spider and camshaft as an assembly.

5. Remove brake chambers from brake chamber brackets, then disconnect steering drag link from steering arm, and tie-rod from steering tie-rod arms.

6. Remove cotter pins, nuts, and washers from steering arm and steering tie-rod arms, at steering knuckles; then drive arms out of knuckles using a heavy lead hammer.

7. Remove cotter pin and nut from upper end of king pin then remove seal retainer and seal. Drive king pin out of knuckle from top using a large brass drift, then remove snap ring, seal retainer and oil seal from king pin.

8. Remove steering knuckle, thrust bearing assembly and spacing washer from axle center, then remove king pin bushing from king pin.

CLEANING AND INSPECTION

1. Clean all steering knuckle parts, thoroughly, in clean gasoline or any other suitable cleaning fluid.

2. Inspect thrust bearing assembly for wear or damage. If inspection reveals excessive wear or irreparable damage, replace with new assembly.

3. Check king pin for wear or pitting. Rough spots may be cleaned up with a hone, provided such cleaning does not materially decrease diameter of king pin. Refer to "Specifications", at end of this section, for diameter of new king pin.

4. Check clearance between king pin and king pin bushing and also clearance between steering knuckle bushings and king pin. Clearances greater than those shown in "Specifications", at end of this section, should be corrected by installation of new bushings.

BUSHING REPLACEMENT

If inspection indicates that steering knuckles need rebushing, suitable puller should be used to remove bushings. If such a tool is not available, any coarse thread tap of suitable size can be screwed into bushing and bushing driven out from inside of yoke with rod, preferably brass, slightly smaller than king pin, and long enough to extend about 1-1/2" through opposite side of yoke.

When installing new bushings, round off their edges slightly, and place in position so that oil holes will line up with fitting. Bushings must enter holes straight, when pressed in with vise or arbor press. NEVER ATTEMPT TO DRIVE BUSHINGS IN WITH HAMMER.

Bushings may be reamed with a two step reamer or burnished with burnishing tool. In either case, tool must have long pilot bar or be of sufficient length to burnish both bushings at same time. After bushings are reamed, make sure that oil grooves are cleaned out and all sharp edges in grooves removed.

STEERING KNUCKLE INSTALLATION

When installing steering knuckle, always check up and down movement of knuckle and install shims at top of I-beam if necessary. Install steering knuckles and king pins in the following manner: Key numbers in text refer to figure 1.

1. Press king pin bushing (5) onto king pin (7), making sure bushing is properly aligned with king pin.

2. With steering knuckle (1) in position on axle center (12), install thrust bearing assembly (11), thrust washer spacer (10), and thrust washer (9), as shown in figure 1.

3. Raise knuckle with jack slightly so that weight of front end will rest on thrust bearing and check clearance between top of I-beam and knuckle yoke. Clearance greater than shown in "Specifications," at end of this section should be corrected by installing a shim (6), of suitable thickness, at top of axle center. Shim thicknesses available are given in "Specifications".

4. Make certain king pin hole in axle center (13), king pin (7), and nut (8), are carefully cleaned and dry. King pin nut (8) should screw on king pin freely without binding in any manner. These precautions should be taken to assure king pin being securely locked in place, when installation is completed.

5. Install oil seal retainer spacing washer, oil seal (3), oil seal retainer (2), and oil seal retainer spring on lower end of king pin.

6. Insert king pin (7) through bottom yoke of steering knuckle (1), then drive king pin into place with a lead hammer.

7. Install new oil seal (3), seal retainer (2) and king pin nut (8). Tighten nut with torque wrench (250 to 350 foot pounds torque), then align cotter pin hole in king pin with slots in nut and install new cotter pin full size of hole.

8. Install steering tie rod arms in right and left-hand steering knuckles. Make certain that arm keys are in place when arms are installed. Install and tighten nuts and washers on steering arms firmly; then lock nuts in place with new cotter pins full size of holes. Install drag link steering arm and brake chamber bracket on left hand steering knuckle and brake chamber bracket with bracket stud on right-hand steering knuckle in same manner.

9. Install brake spider. Install camshaft assembly, and brake shoes as directed under "Front Camshaft and Brake Shoe Installation" in Air Brakes (Sec. 4B, in this manual). Adjust and install drag link on steering arm as directed under "Steering Drag Links" in Steering Gear (Sec. 16, in this manual).

10. Install tie-rod as later described in this section. Install and adjust hubs and bearings. Refer to Hubs and Bearings (Sec. 19A, in this manual). Adjust brakes as directed under Brakes (Sec. 4B, in this manual). Install wheels, then check front end alignment as previously described in "Front End Alignment" (Sec. 1A, in this manual).

FRONT AXLE OVERHAUL

FRONT AXLE REMOVAL

1. Loosen wheel nuts, then raise front of vehicle with jack and block vehicle behind front axle.

2. Disconnect drag link from steering arm, then disconnect brake lines from brake chambers.

3. Disconnect shock absorbers and both ends of each front spring as described in "Spring Suspension" (Sec. 15, in this manual) then roll assembly out from under vehicle.

4. Remove bolts which attach each spring assembly to axle, then remove spring assemblies.

5. Remove steering knuckles as previously described under "Steering Knuckle Removal", in this section.

FRONT AXLE INSPECTION

Make certain that parts are carefully cleaned. Inspect axle center, steering arms, knuckles and tie-rod arms, for twisting, bending or distortion. The "Magna Flux" method is recommended for inspecting parts for cracks or fissures that otherwise, would not be visible to the naked eye.

Heat treated parts which have become bent or twisted more than 5^{0} from original shape, should be replaced with new parts.

When parts are bent or twisted beyond 5^{0} from original form, they are generally twisted beyond their original material elasticity limits. Minute fractures hardly visible, usually occur and these fractures may cause failures under ordinary conditions.

STRAIGHTENING FRONT AXLE

The straightening of twisted front axle forgings MUST be performed only by mechanics thoroughly familiar with such operations, and experienced in the use of special straightening tools.

Heat weakens the original structural qualities of these parts.

Always Straighten Front Axle Forgings Cold- The practice of applying heat to front axle forgings should be discouraged - Under No Conditions Should Heat Be Applied When Straightening These Parts.

FRONT AXLE INSTALLATION

1. Install steering knuckles as previously described under "Steering Knuckle Installation" in this section.

2. Position and install front springs on front axle. Then roll axle assembly under vehicle and attach springs and shock absorbers as directed under "Spring Installation" in Spring Suspension (Sec. 15, in this manual).

3. Connect brake air lines to brake chambers. Install drag link in steering arm. Adjust hub bearings as directed in Hubs and Bearings (Sec. 19A, in this manual), then check brake adjustment as directed in Air Brakes (Sec. 4B, in this manual).

4. Remove blocks which support vehicle, tighten wheel nuts, and check tightness of bolts which attach springs to axle; then check front wheel alignment as directed in Front End Alignment (Sec. 1A, in this manual).

FRONT AXLE

STOP SCREWS

Adjustable stop screws at front axle steering knuckles limit turning angle of front wheels. These stop screws, when correctly adjusted, prevent tire interference with body or chassis.

Adjustment of stop screws is an important operation. If stop screws are adjusted to provide excessive clearance, difficulty may be experienced when making sharp turns. If insufficient clearance exists, tires may contact some point on chassis when turning.

Stop screw should be adjusted to permit not less than 1/2 inch clearance between extreme portion of tire and closest chassis point when wheels are turned to extreme right or left.

ADJUSTMENTS

Note: Pitman arm must be assembled to gear in correct position and steering drag link must be properly adjusted before any attempt is made to adjust stop screws. Refer to Steering Gear (Sec. 16, in this manual), for drag link and Pitman arm adjustment procedures. Adjust stop screws in the following manner:

1. Raise front of vehicle and disconnect steering drag link at Pitman arm.

2. Turn steering wheel and vehicle wheels to extreme right position. Adjust right steering knuckle stop screw until stud hole in Pitman arm is not more than 1/4 inch to rear of drag link stud - or so it is necessary to back Pitman arm not less than 3/4 inch toward straight-ahead position to fit drag link stud into hole in Pitman arm. If tires have less than 1/2 inch clearance from closest chassis obstruction, adjust stop screw until this clearance is obtained.

4. Turn steering wheel and vehicle wheels to extreme left-hand position. Adjust steering knuckle stop screw until stud hole in Pitman arm is not more than 3/4 inch ahead of drag link stud or so it is necessary to move Pitman arm not more than 3/4 inch toward straight-ahead position to fit drag link stud into hole in Pitman arm. If tires have less than 1/2 inch clearance from closest vehicle obstruction, adjust stop screw until this clearance is obtained.

5. Install drag link on Pitman arm and lower front of vehicle to floor.

TIE ROD

Tie rod assembly used is three-piece type comprised of a rod and two end assemblies. Tube is threaded into ends and locked with clamp bolts. Right and left-hand threads are provided on tie rod to facilitate toe-in adjustment.

The stud is held against a bearing cup by a seat and spring. An end plug, secured in place with a lock ring, maintains the parts in correct relative position as shown in figure 2.

MAINTENANCE

Do not permit stud to work loose, or holes in steering tie-rod arms may become enlarged as a result of excessive play. Subsequent tightening of stud nuts may draw studs into steering arms so far, that springs and dust covers may become damaged while turning to extreme right or left.

Normal wear on bearing surface in tie rod end, will cause increase in overall height of assembly. If excessive play is noted, it is evident that worn parts, or complete end assembly must be replaced.

TIE ROD END REPAIR

When it is evident that excessive wear necessitates repairing the tie rod ends, repairs are accomplished in the following order:

REMOVAL AND DISASSEMBLY (Fig. 2)

1. Disconnect tie rod end from steering tie-rod arm. Loosen clamp bolt nuts then remove tie rod end from tie rod.

2. Remove outer dust seal cover (14), outer dust seal (13), inner dust seal cover (12), and inner dust seal (11) from end stud (2).

3. Pry end plug lock (7) out of tie-rod end (4), then remove end plug (6), end stud seat spring (5), end stud seat (9), grease retainer (8), end stud (2), end stud bearing (3), and end stud bearing seat (10) from tie-rod end.

CLEANING AND INSPECTION

Immerse all parts except dust seal covers (12 and 14) in cleaner use a stiff bristle brush as required, and clean parts thoroughly. If any parts show evidence of wear or corrosion, install new parts. Check tension of spring, if tension of spring is not within limits listed in "Specifications" at end of this section, install new spring.

Carefully inspect rollers in end stud bearing assembly for roughness or flaking. If rollers will not rotate freely in retainer, bearing assembly should be replaced.

ASSEMBLY AND INSTALLATION (Fig. 2)

1. Lubricate parts with lubricant specified in Lubrication (Sec. 13, in this manual), then place end stud bearing (3) and end stud bearing seat (10) on end stud (2).

2. Insert stud and bearing assembly into tie-rod end (4), then press grease retainer (8) over end of end stud seat (9).

3. Place stud seat in tie-rod end (4) then install end stud seat spring (5) and end plug (6). Secure all parts in tie-rod end (4) with end plug lock (7).

4. Install on threaded end of stud, in the following order, inner dust seal (11), inner dust seal cover (12), outer dust seal (13), and outer dust seal cover (14).

5. Install tie rod end assembly on tie rod tube; then install stud on steering tie-rod arm. Install clamp bolts, new lock washers and nuts but do not tighten nuts at this time.

6. Adjust toe-in as directed later in this section. After toe-in adjustment has been completed, tighten both clamp bolt nuts firmly and lubricate tie-rod ends as specified in Lubrication (Sec. 13, in this manual).

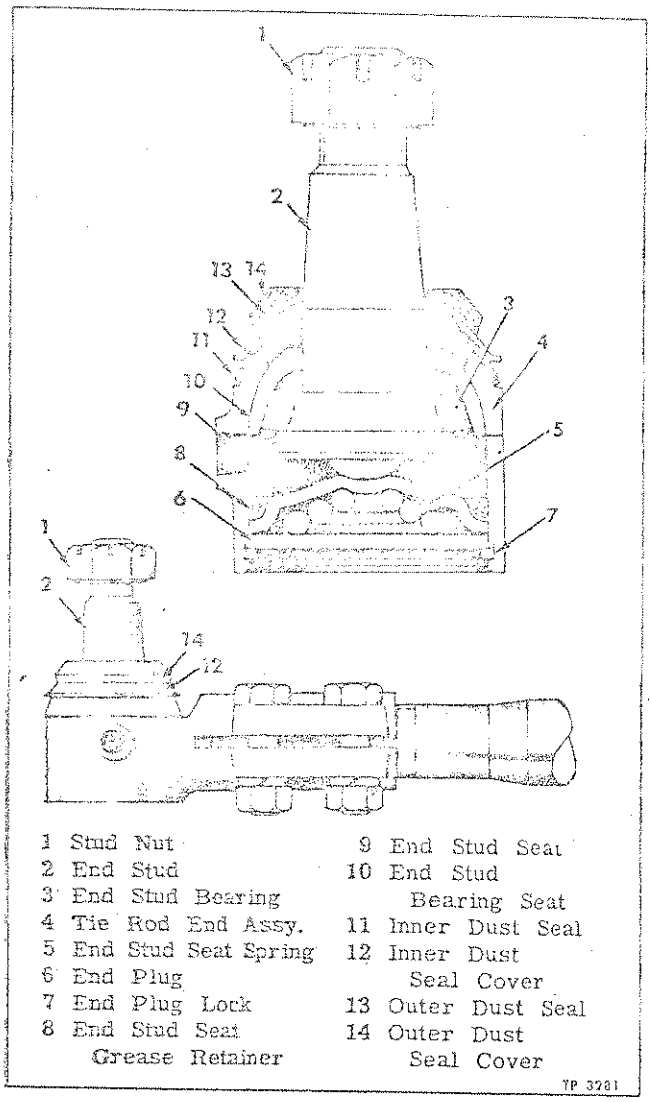


Figure 2—Tie Rod End Sectional View

FRONT WHEEL TOE-IN ADJUSTMENT

Loosen two clamp bolts at each end of tie rod and turn tie rod with wrench until correct toe-in is obtained. Opposite ends of tie-rods should be in same plane before clamp bolts are tightend. After clamp bolts are tightened, tie-rod ends must not bind in steering arms when wheels are turned to extreme right or left.

Tie rod ends should be lubricated at intervals shown in Lubrication (Sec. 13, in this manual).

IMPORTANT

A careful inspection of front axle parts is important, particularly after a severe curb bump or collision.

FRONT AXLE

SPECIFICATIONS

STEERING KNUCKLES

Diameter at Inner Bearing	2.5613 - 2.5623 in.
Diameter at Outer Bearing	2.1243 - 2.1248 in.
Bushing I.D. (Burnished)	1.717 - 1.718 in.
Bushing O.D.	2.132 - 2.128 in.
Bushing Length	2-11/64 in.
Thrust Washer Thickness	0.150 - 0.160 in.

KING PIN

Diameter at Top of Pin	1.309 - 1.310 in.
Diameter at Bottom of Pin	1.716 - 1.717 in.
King Pin Bushing I.D.	1.310 - 1.311 in.
King Pin Bushing O.D.	1.7155 - 1.7165 in.
King Pin Bushing Length	2-1/2 in.
King Pin Nut Torque - Minimum	250 ft. lbs.

Clearance Between

King Pin Bushing and Knuckle Bushing	0.0005 - 0.0025 in.
King Pin and Lower Knuckle Bushing	0.000 - 0.002 in.
King Pin and King Pin Bushing	0.000 - 0.002 in.
Top of Axle Center and Steering Knuckle	0.015 in. Max.
Adjustment	Shims
Shim Thickness Available	0.010 and 0.020 in.

TIE ROD END

End Stud Seat Spring

Free Length	3/4 in.
Solid Height	27/64 in.
Compressed to 1/2 in.	350-400 lbs.

AXLE CENTER (I-BEAM)

Twist: Allowable Variation Between Ends	1/2°
Spring Centers	42 in.

Rear Axle – Early Type

Contents of This Section

Related Subjects in Other Sections

Rear axle is full floating type. One-piece axle housing has spring pads integral with housing and housing bowl is offset toward right side of vehicle. Drive pinion assembly is mounted at an angle as later illustrated in figure 1. Drive is transmitted from transmission angle drive unit through propeller shaft, spiral bevel, axle housing, and springs to vehicle underframe. Differential and pinion shaft assemblies both incorporate adjustments for bearings and gear tooth contact.

CONSTRUCTION

DIFFERENTIAL CARRIER

Differential assembly, pinion shaft and cage assembly, are mounted in differential carrier. After axle shafts have been removed, and propeller shaft has been disconnected, differential carrier can be removed for inspection and adjustment without removing axle housing from vehicle.

DIFFERENTIAL ASSEMBLY

Conventional four-pinion type differential is carried in two-piece case mounted on tapered roller bearings. Bevel drive gear is bolted to flange half of differential case. Drive gear and pinion are furnished in matched lapped sets and should always be installed as such to assure satisfactory operation.

Thrust washers are used between differential side gears and case and differential pinions and case. Each pinion contains an aluminum bronze bushing. When bushings become worn, pinions must be replaced. Differential case halves are held together with special bolts and castellated nuts, locked in place with lock wire.

DIFFERENTIAL SIDE BEARINGS

Differential case is supported in tapered roller bearings which take thrust as well as radial loads. Bearings are mounted in machined supports in differential carrier with thrust loads taken against adjusting rings threaded into carrier supports and bearing caps. Adjusting rings bear against bearing cups and are locked in position by adjusting ring locks bolted to each bearing cap.

DRIVE PINION AND CAGE ASSEMBLY

Drive pinion is straddle mounted in two opposed tapered roller bearings at outer end, and one straight roller bearing at inner end. Tapered roller bearing cups are installed in a pinion cage as shown in figure 1 and are separated by a machined shoulder in cage. Bearing cones are assembled on pinion shaft and are adjusted on shaft by adjusting nut and thrust washer. Bearing at inner end of pinion is pressed on stub end of shaft and secured in place by retainer and bolt.

Shims of various thicknesses are used between bearing cage and differential carrier to adjust drive pinion tooth contact.

Pinion shaft and cage assembly cannot be removed from carrier until differential case assembly including drive gear has been removed from carrier.

AXLE SHAFTS AND HOUSING

Axle shafts are full floating type. Drive flange at outer ends have external teeth which mesh with

REAR AXLE (EARLY TYPE)

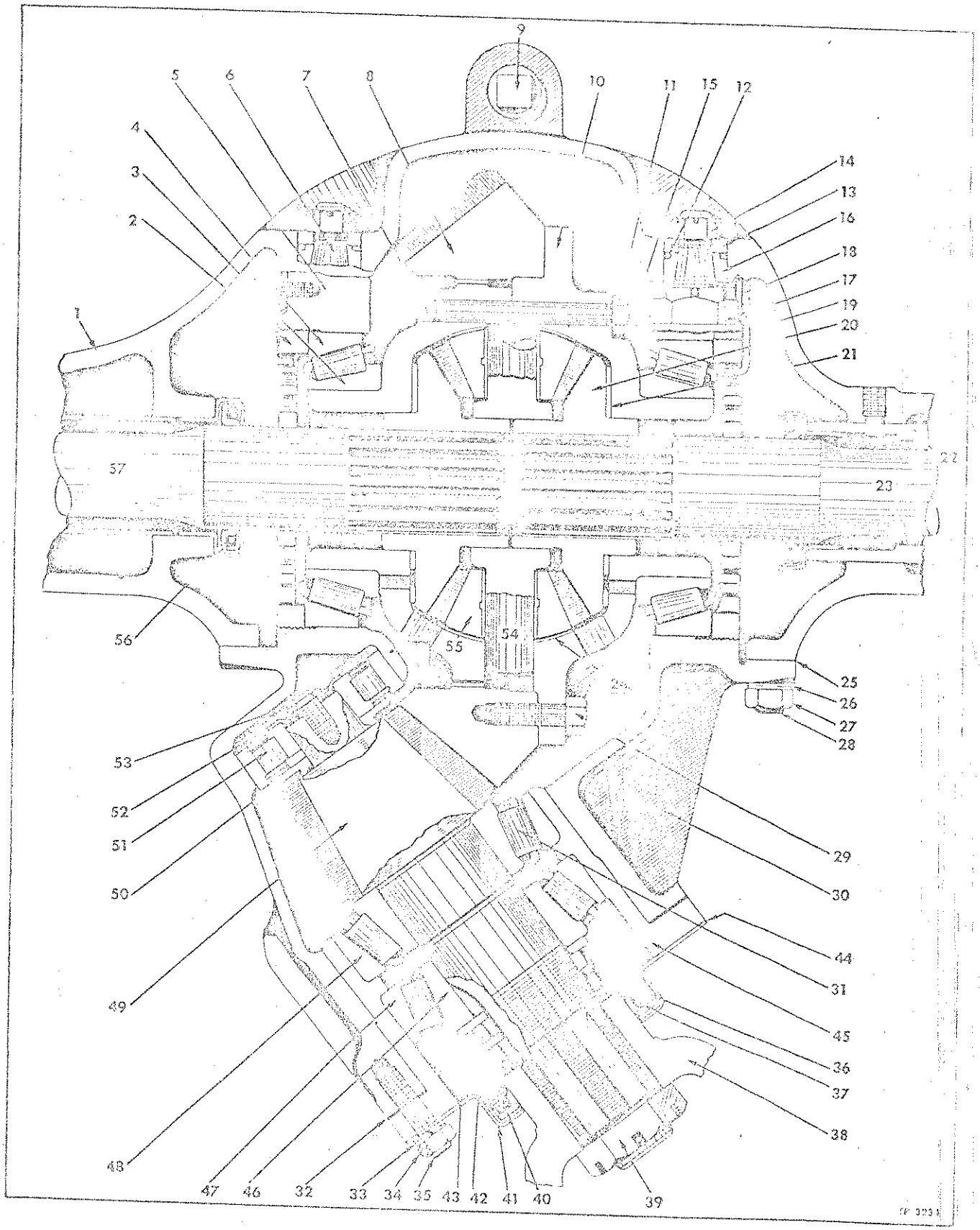


Figure 1—Cross Section View of Rear Axle

REAR AXLE (EARLY TYPE)

1 Axle Housing
2 Adjusting Ring
3 Differential Side Bearing Cone
4 Differential Side Bearing Cup
5 Differential Bearing Cap
6 Differential Bearing Cap Support Stud
7 Differential Case Bolt
8 Bevel Drive Gear (Matched)
9 Filler Plug
10 Differential Case
11 Differential Case Bolt Nut
12 Support Bushing Gasket
13 Support Stud Washer
14 Support Stud Nut
15 Lock Wire
16 Support Stud Bushing
17 Differential Bearing Cap Stud Nut
18 Adjusting Ring Lock Bolt
19 Adjusting Ring Lock
20 Differential Side Gear
21 Differential Side Gear Thrust Washer
22 Housing Outer End Tube
23 Axle Shaft (Right Hand)
24 Differential Pinion Thrust Washer
25 Differential Carrier Gasket
26 Lock Washer
27 Differential Carrier Stud Nut
28 Differential Carrier Stud
29 Drive Gear Bolt
30 Differential Carrier Assembly
31 Inner Drive Pinion Bearing (Tapered Roller)
32 Drive Pinion Cage Shims
33 Lock Washer
34 Stud Nut
35 Drive Pinion Cage Stud
36 Adjusting Nut Lock
37 Drive Pinion Lock Nut
38 Universal Joint Flange
39 Drive Pinion Nut
40 Oil Seal
41 Drive Pinion Bearing Cover
42 Adjusting Nut
43 Thrust Washer
44 Drive Pinion Bearing Cover Gasket
45 Drive Pinion Bearing Cage
46 Outer Drive Pinion Bearing Cone (Tapered Roller)
47 Outer Drive Pinion Bearing Cup
48 Inner Drive Pinion Bearing Cup
49 Drive Pinion (Matched)
50 Bearing Spacer
51 Inner Drive Pinion Bearing (Straight Roller)
52 Bearing Retainer
53 Bearing Retainer Bolt
54 Differential Spider
55 Differential Pinion
56 Inner Axle Shaft Oil Seal Assembly
57 Axle Shaft (Left-Hand)

TP 3234 B

Captions For Figure 1

similar internal teeth on hub drive plate. Drive plate is doweled to hub with dowel pins and held in place together with plate cover with ten hub studs and nuts as later shown in figure 8.

Axle housing is one-piece design with differential located off center. Housing is equipped with removable outer end tubes which are threaded to accommodate wheel bearing adjusting nuts.

AXLE MAINTENANCE ON VEHICLE

At regular intervals, the rear axle should be inspected as follows:

1. Axle Shaft Cover Stud Nuts. Examine stud nuts and studs which secure drive plate covers on hubs for looseness and tighten nuts firmly if necessary. Use new lock washers under nuts if required.

2. Lubricant Leaks. Check pinion shaft oil seal and cover gasket, axle shaft plate and cover gaskets, and differential carrier gasket for leaks. Correct leaks by tightening bolts and stud nuts, or by replacing gaskets or oil seals.

3. U-Bolts. Check and tighten spring bolts. Examine axle for misalignment. This can be done by measuring from rear spring front bracket bolt to end of axle. A measurement taken between identical points at opposite end of axle should be the same as first measurement, if axle is properly aligned.

4. Axle Housing Check. If bent axle housing is suspected, check as directed under "Axle Repair" later in this section.

5. Lubricant. Check lubricant level at regular intervals. Add lubricant as required. Refer to Lubrication (Sec. 13, in this manual), for correct type of differential lubricant.

Housing should be kept filled to level of filler plug. Drain plug is at lowest point of housing.

REAR AXLE (EARLY TYPE)

AXLE SHAFT REPLACEMENT

AXLE SHAFT REMOVAL

1. Remove outer drive plate cover, cover spring and gasket. Insert 1/2"-13 cap screw in tapped hole in axle flange. Screw should be long enough to pull axle flange free from drive plate teeth. Withdraw axle shaft from housing.

2. If it is necessary to remove drive plate, do not remove axle shaft. Instead, use a suitable puller which will exert pressure on flange and may be attached to drive plate with three 1/2"-13 cap screws of sufficient length so drive plate teeth will clear flange teeth.

AXLE SHAFT INSTALLATION

1. Before axle shafts are installed, ascertain that hub bearings are in proper adjustment; then insert drive plate dowel pins into place. Three gaskets are used at flange end of each axle. Namely, between hub and drive ring, drive plate and drive ring, and between drive plate and plate cover.

2. Install over end of hub studs in sequence, gasket, drive ring, gasket and drive plate; then dip splined end of axle shaft in differential lubricant and insert shaft into hub. Align shaft splines with side gear splines, and flange teeth with drive plate teeth; then push shaft into place and install cover gasket. Make certain the small spring between drive plate cover and shaft flange is located correctly on bosses of flange and cover.

3. Install nuts and new lockwashers on studs; then tighten nuts alternately and firmly.

AXLE ASSEMBLY REPLACEMENT

AXLE ASSEMBLY REMOVAL

1. Remove drain plug and drain lubricant from axle housing. Loosen wheel stud nuts until nuts are finger tight.

2. Place jacks under axle housing, then raise vehicle. When rear of vehicle is supported with blocks placed in front of rear axle and jacks are removed, wheels should clear floor.

3. Remove jacks after blocks are securely in place under vehicle. Remove rear wheel stud nuts, then remove wheels.

4. Disconnect brake air lines at brake chambers.

5. Disconnect propeller shaft slip joint dust seal cap. Refer to Propeller Shaft (Sec. 18, of this manual), for complete information on propeller shaft removal.

6. Loosen spring U-bolt nuts until nuts are finger tight.

7. Place a suitable dolly jack under axle housing. Be sure axle is cradled securely and properly balanced on jack. Raise axle assembly sufficiently to take weight of axle off springs.

8. Remove spring bracket side plates at rear end of both rear springs. Refer to Spring Suspension (Sec. 15, of this manual). Lower axle permitting springs to pivot on front shackle pins.

9. Remove spring U-bolts to free axle from springs.

10. Remove axle assembly by pulling dolly jack, supporting axle, out from under rear end of vehicle. Rear springs need not be removed from vehicle.

AXLE ASSEMBLY INSTALLATION

1. Carefully check, inspect and replace, as necessary, parts in propeller shaft universal joints, rear spring mountings, wheels and rear hubs. Each of these items is covered in detail, in its respective section elsewhere in this manual.

2. With rear axle completely assembled and supported on dolly jack, roll assembly into place under vehicle. Assemble propeller shaft slip joint. Align axle as required to accomplish assembly. Arrow markings on propeller shaft must be in alignment to assure assembling of universal joints in proper plane and balance. Refer to Propeller Shafts (Sec. 18, of this manual).

3. Position axle housing on springs and align center bolt head in recess provided in housing for center bolt. Position U-bolt spacer on top of housing, then install U-bolts on spacer and housing. Place spring retainer plate over ends of U-bolts and install nuts on U-bolts, finger tight.

4. Raise axle housing and align rear ends of spring in position. Install spring brackets as directed in Spring Suspension (Sec. 15, of this manual).

5. Lower dolly jack, then tighten U-bolt nuts firmly.

6. Connect brake air lines at brake chambers, refer to Brakes (Sec. 4B, of this manual).

7. Install rear wheels and tighten stud nuts. Refer to Wheels and Tires (Sec. 19B, of this manual).

8. Raise dolly jack under axle housing sufficiently to remove blocks which support vehicle, then lower jack and remove from under vehicle.

9. Be sure that axle housing is filled to correct level with proper lubricant and filler plug installed. Refer to Lubrication (Sec. 13, of this manual).

REAR AXLE REPAIR

The following instructions provide procedures for removal, complete disassembly, cleaning, inspection, repair and assembly of rear axle.

Axle shafts and differential carrier assembly may be removed from axle housing for repair or replacement without removing entire axle assembly from the vehicle. For a complete inspection and rebuilding of the entire assembly, it is recommended that rear axle be removed from the vehicle.

AXLE HOUSING CHECK (Before Removal)

At regular intervals, or when it is suspected that rear axle is bent, a check should be made by the following method. This check can be made before the axle assembly is removed from the vehicle, and in that manner determine the extent of repairs required. The check is made with conventional front end alignment camber and toe-in equipment.

1. Check hub bearing adjustment and adjust bearings if required. Refer to Hubs and Bearings (Sec. 19A of this manual). Check rear wheels for run-out or "wobble" in the following manner:

a. Place vehicle on smooth level floor; then raise rear axle with a jack and place supports under each side of axle housing.

b. Make certain that wheels are mounted solidly on hubs and that wheel nuts are tightened firmly. Position a spring type scriber or marker (same type used to mark center of tire treads when checking front end alignment), at right angle to rear outside wheel rim. Point of scribe should be placed 1/8" away from wheel rim.

c. Revolve wheel slowly, and at the same time, note if rim of wheel contacts point of scriber or, if gap between scriber point and rim increases or diminshes. If run-out exceeds 3/32 inch (new limits), wheel should be replaced with one that does not exceed new limits. Perform check on both rear wheels.

2. Lower wheels to floor. Place a conventional camber gauge on rim of wheel. Note reading, if reading exceeds 0 degree, plus or minus 1/4 degree, axle housing is bent on that side. Repeat check on opposite wheel and note reading on camber gauge. If reading exceeds 0 degree, plus or minus 1/4 degree, that side is also bent.

3. Place a conventional toe-in gauge between inner tires in front of rear axle under vehicle close to bottom side of springs. Note reading at each end of instrument; then carefully roll vehicle forward until instrument is close to bottom side of springs at rear of vehicle. Again note readings at ends of instrument, if second reading exceeds the first by more than 1/4 degree, the side (right or left) of the axle on which the variation exists, is bent forward or backward as denoted by the reading.

AXLE DISASSEMBLY

(Key Numbers in Test Refer to Fig. 1)

Before and during disassembly operations, a preliminary inspection and check of all adjustments should be made to determine repairs required. Perform these procedures in order given.

1. Perform a visual check on the exterior of axle housing for leaks, damage, cracks, etc., which are usually detected before axle housing is cleaned. Note all evident conditions to assist in the repair of axle assembly. After inspection is completed, clean exterior of axle housing thoroughly with a suitable cleaning fluid and a stiff bristled brush, or use steam cleaning.

2. Check drive gear and pinion backlash.

3. Check pinion depth in dirve gear and note if excessive end play exists in pinion bearings.

4. Check each bolt which is used to attach drive gear to differential case flange for looseness. Check drive gear run-out before removing differential case assembly from carrier.

DIFFERENTIAL CARRIER REMOVAL
(Key Numbers in Text Refer to Fig. 1)

1. Remove axle shafts as previously instructed under "Axle Shaft Replacement" in this section.

2. Remove drain plug and drain lubricant from housing while loosening differential carrier stud nuts. Place suitable dolly jack under differential carrier to support during removal.

3. Remove nuts (14) and washers (13), from bearing cap support studs (6). Remove nuts (27) and lock washers (26), from differential carrier studs (28); then pull differential carrier as assembly out of axle housing.

4. Remove bushings (16) and gaskets (12). Be particularly careful that none of these parts drop into axle housing and remain there.

DIFFERENTIAL CASE REMOVAL

1. Remove lock wire from bolts (18) which secure locks (19). Mark bearing caps (5) and differential carrier (30) so caps (5) may be installed in the same relative position.

2. Remove nuts (17) from bearing cap studs (6), then remove bearing caps (5), rings (2), and lift differential assembly including cups (4), gear (8) and side bearings (3) out of carrier.

DIFFERENTIAL CASE DISASSEMBLY (Fig. 1)

1. Use CS-1047 puller (fig. 2) to remove bearing cones which are pressed on hubs. This

REAR AXLE (EARLY TYPE)

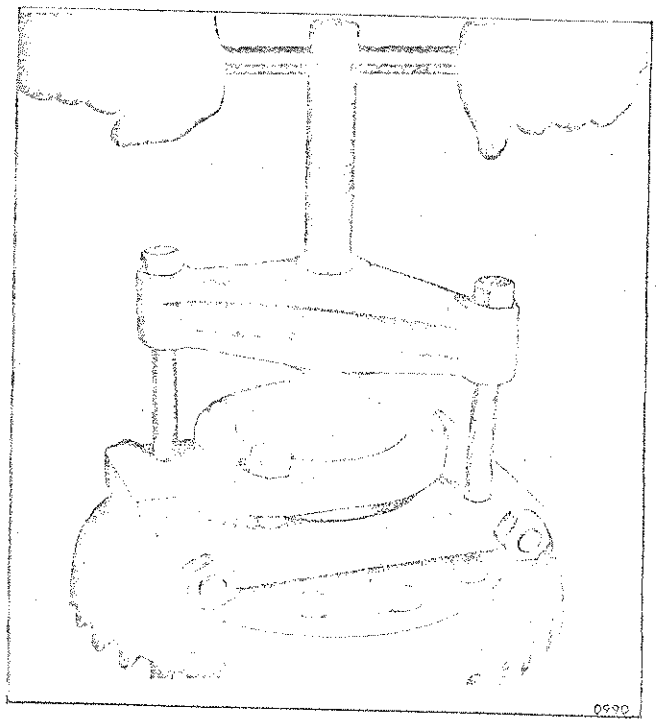


Figure 2—Removal of Differential Side Bearings (Tool No. CS-1047)

completely removes side bearings (2).

2. Before disassembling differential case (10) be sure both sections are marked (fig. 3), so parts can be assembled in same relative position.

3. Cut lock wire (15) and remove nuts (11) from bolts (7), then pull case sections (10) apart. Remove bolts (29) from bevel gear (8), then remove gear (8) from case flange.

4. Remaining parts of differential can now be removed from case (10). These parts are thrust washers (21 and 24), side gears (20), pinion gears (55) and spider (54).

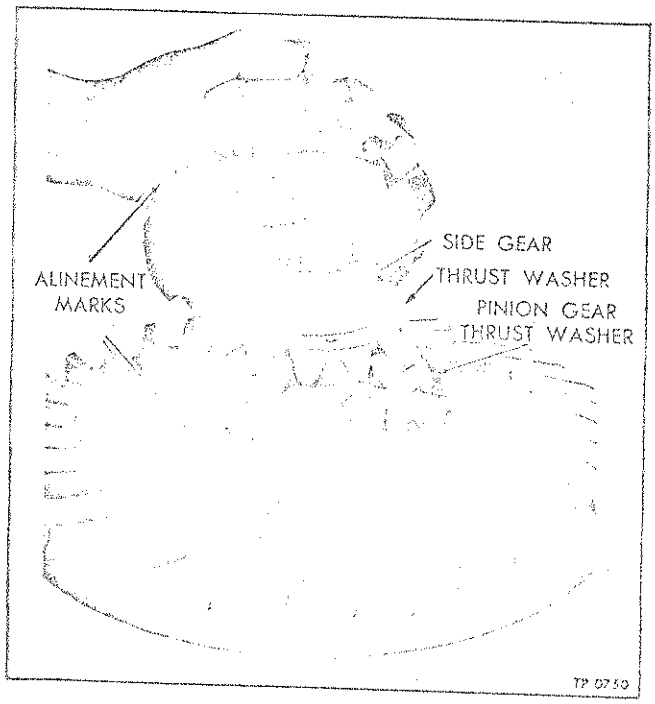


Figure 3—Typical Differential Case Showing Alignment Marks

DRIVE PINION CAGE REMOVAL AND DISASSEMBLY (Fig. 1)

After differential assembly has been removed from carrier (30), drive pinion (49) and pinion cage assembly (45) are removed and disassembled in the following manner:

1. Mark pinion cage (45) and differential carrier (30) in a suitable manner with hammer and chisel so parts may be reassembled in same relative position.

2. Remove nuts (34) and lock washers (33) from studs (35). Install and tighten puller screws alternately until pinion cage (45), bearing and drive pinion assembly are free in carrier (30); then remove cage (45) assembly from carrier (30). Remove and tie shim (32) pack together to retain original shim pack to be installed at reassembly.

3. Remove bolt (53) and retainer (52) which secure inner bearing (51) on drive pinion (49); then remove inner bearing (51) and bearing spacer (50) from drive pinion (49).

4. Clamp flange (38) in a vise. Remove cotter pin and nut (39) from drive pinion (49). Remove flange (38), cover (41) and oil seal (41) assembly, and gasket (54) from cage.

5. Pry nut lock (36) lip away from lock nut (37); then remove lock nut (37), (fig. 4) nut lock (36), adjusting nut (42) and thrust washer (48), from drive pinion (49).

6. Position drive pinion and cage assembly in an arbor press and press drive pinion (49) out of pinion cage (45) and outer bearing (46). Remove outer bearing (46) from pinion cage (45). Use special bearing puller CS-1047, to remove inner bearing (31) from drive pinion (49).

7. Bearing cups (47 and 48) may be removed (if necessary) from pinion cage (46) with a brass drift and hammer.

CLEANING, INSPECTION, AND REPAIR

Cleaning Bearings

1. Immerse differential and drive pinion bearings in gasoline, kerosene, or other suitable cleaning fluid. Leave bearings in fluid long enough so fluid will dissolve and loosen old lubricant. After bearings have been soaked in fluid a sufficient length of time, bearings should be alternately slushed up and down and spun slowly below the surface of liquid to remove old lubricant.

2. Remove bearing from fluid, then strike large side of bearing flat against wooden block to jar loose heavy and larger particles of lubricant, Repeat until bearings are thoroughly clean.

3. Rinse bearings out in clean fluid, then blow bearings dry with compressed air. CAUTION: Do not spin bearings while blowing them dry with compressed air. After bearings have been inspected as later described in this section of the manual, and bearings are going to be used, dip bearings in differential lubricant recommended in Lubrication (Sec. 13, in this manual), and wrap in clean cloth or paper until needed.

Cleaning Parts

1. Immerse all parts in suitable cleaning fluid and clean parts thoroughly. Use a stiff bristle brush as required to assure removal of any accumulation of old lubricant, etc., which may be evident. Remove particles of gaskets which may adhere to mating faces of axle housing, differential carrier, cover oil seal retainer, hubs and axle shaft flanges. Clean lubricant channels in pinion cage and differential carrier as required. Clean breather type screw. Make certain that axle housing is thoroughly cleaned.

INSPECTION

Whenever available, the Magna Flux Method should be used on all steel parts, except ball and roller bearing. This method is especially suited for inspection of ground or highly finished surfaces for wear and cracks which otherwise would not be visible to the naked eye.

Inspection Operations

1. Bearings. Rotate each bearing slowly, and at the same time examine bearing for roughness, damage, defects, or wear, Note condition of bearing cage and replace bearing if cage is damaged or if any of the conditions previously noted are evident.

2. Gears. Examine drive gear and drive pinion, differential side gears closely for damaged teeth, worn spots in surface hardening and distortion. Examine bushings in differential pinions for grooves, or excessive wear and check fit of gears on spider. Refer to "Specifications" later in this section for limits. Inspect drive gear rivets for looseness, replace loose rivets. Check radial clearances between differential side gears and differential pinions on spider. Refer to "Specifications" at end of this section for limits.

3. Differential Case. Inspect differential case assembly for cracks, distortion or damage, if case is in good condition, thoroughly clean case and cover; then assemble case with bolt and mount in lathe centers or "V" block stand. If lathe is not available, install differential side bearings and mount case in differential carrier as directed under "Differential and Drive Gear Installation" later in this section. Install dial indicator and check differential case run-out. Refer to "Specifications" at end of this section, for run-out limits. Whenever run-out exceeds limits differential case run-out may be corrected as later described under "Repair" in this section.

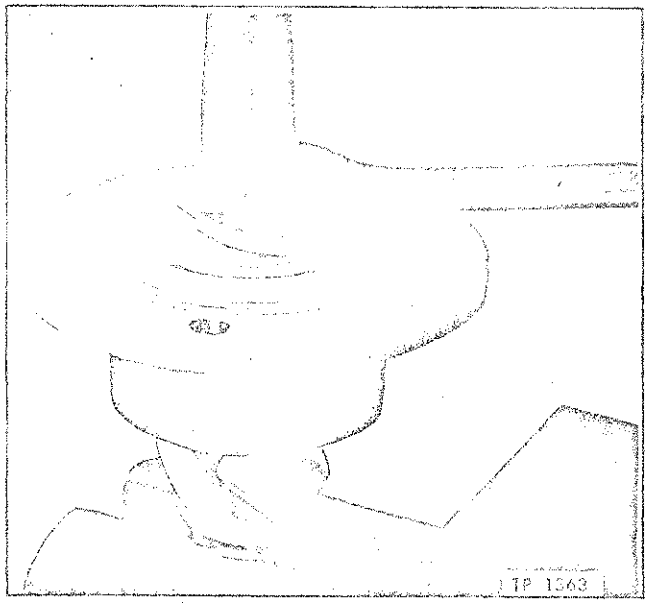


Figure 4—Drive Pinion Cage Disassembly

4. Axle Shafts. Examine splined end of axle shaft for twisted or cracked splines, twisted shaft, and worn dowel holes in flange. If any of above conditions are evident, install new shaft.

5. Axle Shaft and Flange Run-out. Install axle shaft assembly in lathe centers or "V" blocks and check shaft run-out with dial indicator, if run-out exceeds limits listed under "Specifications" at end of this section, discard axle shaft. Position dial indicator so that indicator shaft end contacts inner surface of flange near outer edge of flange and check flange run-out. Whenever run-out exceeds limits listed under "Specifications" at end of this section, discard axle shaft.

Axle Housing Inspection

1. Thoroughly clean inside of housing as well as outer ends. Temporarily install wheel hubs. Refer to Hubs and Bearings (Sec. 19A, of this manual), and Lubrication (Sec. 13, of this manual).

2. Adjust wheel bearing nuts so that hubs will just turn; however, do not lock adjustment at this time. Install axle shafts, dowels and nuts; then tighten nuts firmly. NOTE: Axle shafts should be inspected as previously described under "Inspection Operations" in this section, before installation.

REAR AXLE (EARLY TYPE)

3. Indicators, as shown in figure 5, may be made locally from welding or drill rod (3/16" diameter) to dimensions shown. Make certain that burrs on axle shaft splines have been removed. Install indicators in place as shown in figure 5. Radiator hose clamps of suitable diameter may be used to secure indicators in position.

4. Each indicator must be positioned at right angle to its respective axle shaft after it is secured in place. Both indicators must be in alignment with each other. There should be a slight gap between the points as shown in figure 5. Insert a feeler gauge or measure gap between the indicator points, and make note of this dimension.

5. Place both indicators in alignment, then rotate both shafts simultaneously. Make a check of the gap dimensions between the indicators at four points 90 degrees apart, as shown in figure 5. If the gap at each point exceeds original predetermined gap by more than 1/16", axle housing is bent and should be straightened or replaced.

Oil Seal Inspection

Replacement of spring loaded oil seals whenever unit is disassembled is more economical than premature overhaul to replace these parts at a future time. Further, loss of lubricant through a worn seal may result in failure of other parts, such as gears and bearings.

Handle seals carefully, particularly when seals are being installed. Cutting, scratching or curling under of lip of seal seriously impairs efficiency of seal. Use of Permatex or equivalent around outer diameter of seal is recommended to insure against leakage at that point.

REPAIR

Differential Case. Excessive run-out on differential case may be corrected by machining flange on gear side of case. Remove sufficient metal from gear face of flange on differential case to correct excessive run-out. The metal must be cut on a true plane removing just enough metal to bring run-out within limits listed under "Specifications" at end of section. After differential case has been machined, remove burrs and clean case assembly thoroughly.

Propeller Shaft Flange. Whenever inspection indicates that exterior surface of flange which contacts oil seal is corroded or pitted, the condition may be corrected by cleaning and polishing surface with a suitable abrasive cloth. If cleaning and polishing surface of flange does not clear up the condition, discard flange and install new parts.

REASSEMBLY

(Key Numbers in Text Refer to Fig. 1)

Before the axle is reassembled, make certain that all parts have been thoroughly cleaned, and that a thin coating of differential lubricant speci-

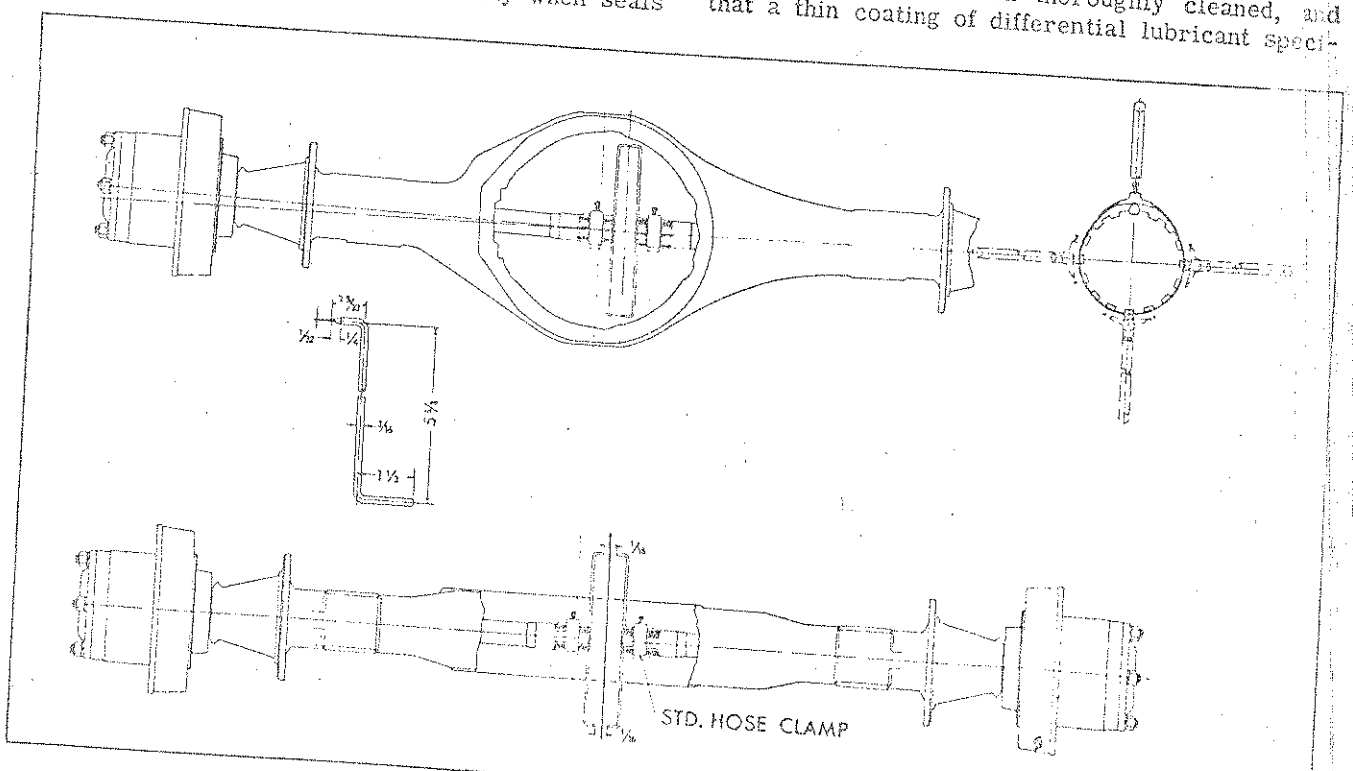


Figure 5—Housing Alignment Check

fied in Lubrication (Sec. 13, in this manual), is applied on all thrust and bearing surfaces to prevent scoring of parts when vehicle is first placed in service.

New lock washers, gaskets, and oil seals are recommended throughout during reassembly of axle. Make certain that all threads on bolts, screws, etc., are in good condition before they are installed.

Adjustments must be carefully made to insure efficient and continuous operation.

DRIVE PINION AND CAGE REASSEMBLY
(Key Numbers in Text Refer to Fig. 1)

Note relative position of bearing parts as previously shown in figure 1. Make certain that bearings are assembled to conform to figure 1.

1. Press bearing cups (47 and 48) into pinion cage (45), if bearing cups were removed during disassembly.

2. Install bearing (31) on drive pinion (49) with widest portion of bearing (31) toward heel of gear teeth (49). Make certain that bearing bottoms solidly against teeth of drive pinion (49).

3. Secure inner end of drive pinion (49) in vise equipped with padded jaws. Position cage (45) over splined end of drive pinion (49); then install bearing (46) in cage (45).

4. Install washer (43) on top of bearing (46) screw adjusting nut (42) on top of washer; then tighten adjusting nut (42) until there is not perceptible end play evident. Test adjustment with torque wrench as shown in figure 6. If torque resistance is less than 6 inch-pounds, tighten adjusting nut (42) - if more than 8 inch-pounds loosen nut. After proper adjustment is secured, install nut lock (42) and lock nut (37), tighten lock nut (37) and check adjustment again to ascertain that tightening lock nut did not change bearing adjustment. Then bend nut lock (36) lip against adjusting nut (43) on one side, and against lock nut (37) on the other side.

5. Carefully insert flange (38) into cover (41) and oil seal (40) assembly; then position cover gasket (54) on top of pinion cage (45). Insert splined end of drive pinion (49) into flange (38) and install nut (39) onto drive pinion (49).

6. Secure flange (38) in vise equipped with padded jaws, tighten nut (39) firmly; then align slots in nut (39) with cotter pin hole and install new cotter pin.

7. Install shim pack (32) which was removed at disassembly, over ends of studs (35). Insert drive pinion and cage assembly into differential carrier (30). Ascertain that marks previously made during disassembly on carrier (30) and cage (45) are in alignment. Align gasket (44) with stud holes in pinion cage (45) and cover (41); then

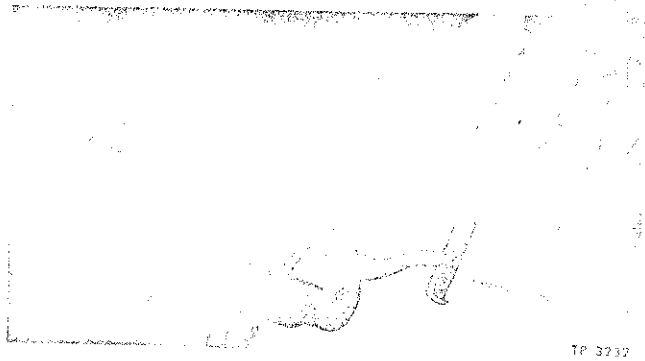


Figure 6—Typical Pinion Bearing Adjustment Test (Tool No. ABV-129)

push pinion cage (45) into place in carrier (30). Install nuts (34) and new lock washers (33) on studs (35). Then tighten nuts alternately and firmly.

DIFFERENTIAL CASE REASSEMBLY (Fig. 1)

1. Before assembling differential case, ascertain that differential case run-out has been checked as previously described in this section under "Inspection Operations."

2. Dip side gears (20), pinion gears (55), thrust washers (21 and 24) and spider (54) in differential lubricant; then permit excess lubricant to drain off parts. Install pinions (55) and thrust washers (24) on spider (54). Install washers (21) on hubs of gears (20). Place one gear (20) and washer (21) in left-hand section of case (10), position spider assembly on top of gear (20), then install other gear (20) and washer (21) on top of spider assembly.

3. Place right-hand section of case (10) in position on top of left section of case. Alignment marks (fig. 3) on sections of case must register correctly to be certain that case is assembled in original relative position. Insert bolts (7) into left-hand section of case (10) and through right-hand section; then install nuts (11) on bolts (7) and tighten nuts firmly. While nuts are being tightened, align slots in nuts (11) with holes in bolts (7) so that lock wire (15) can be installed to lock nuts in place after nuts (11) are tightened. Insert lock wire (15) through bolts, draw wire taut and secure ends of wire together.

4. Assemble drive gear (8) onto differential case (10), install bolts (29) which are used to attach gear (8) to case (10), then tighten bolts (29) securely and insert lock wire through heads of bolts (29) in such a manner so that lock wire will tighten if bolts loosen.

5. Install bearings (3) on case hubs (10) with a suitable piece of tubing which will bear on inner race of bearing (23). Make certain that bearings seat solidly on hubs of case.

REAR AXLE (EARLY TYPE)

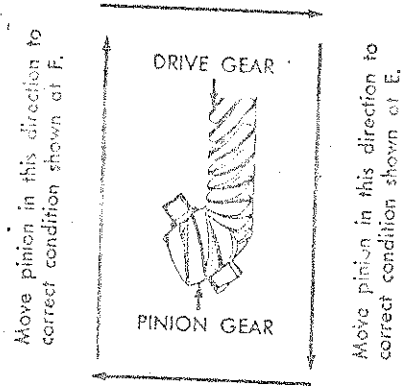
INSTRUCTIONS

1—Install pinion with pinion bearings adjusted for proper end-play. Install differential assembly so that with bearings properly adjusted there will be sufficient backlash to permit final adjustment of pinion position to bring heels of teeth flush.

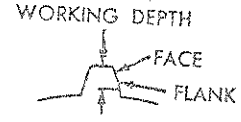
2—Paint three or four teeth of drive gear with red lead or Prussian blue and rotate pinion until bevel gear makes complete revolution.

3—Vary position of pinion and drive gear as per chart until proper tooth contact is obtained. Be sure that sufficient backlash has been allowed so that drive gear can be completely revolved without any highspots being felt.

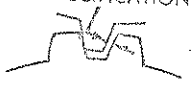
Move gear in this direction to correct condition shown at D.

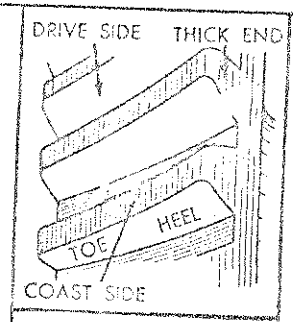


Move gear in this direction to correct condition shown at C.

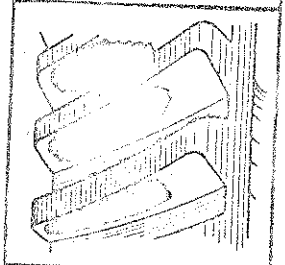


BACKLASH
SEE SPECIFICATIONS

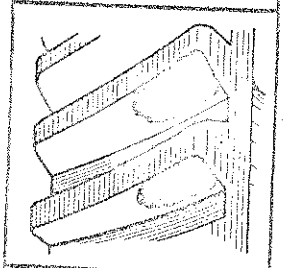




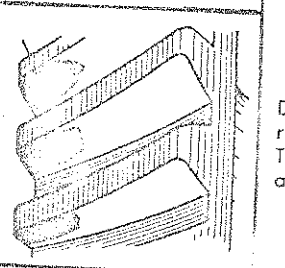
A—Check adjustments on drive side of drive gear tooth. Coast side will then automatically show a desirable tooth contact when adjusted correctly.



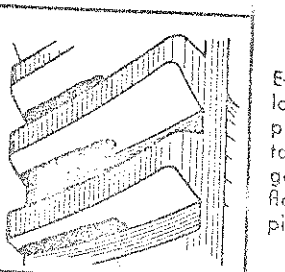
B—Shows correct tooth contact.



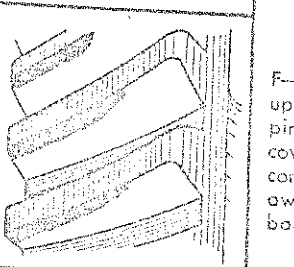
C—Shows short contact at heel. To correct, move drive gear toward pinion. Then move pinion away from drive gear to again secure correct blacklash.



D—Shows short contact at toe. To correct, move drive gear away from pinion. Then move pinion toward drive gear to again secure correct backlash.



E—Shows heavy contact on flank or lower portion of tooth. To correct, move pinion away from drive gear until contact comes to full working depth of gear tooth without breaking contact at flank. Then move drive gear toward pinion to secure correct backlash.



F—Shows heavy contact on face or upper portion of tooth. To correct, move pinion toward drive gear until contact covers flank of tooth without breaking contact at face. Then move drive gear away from pinion to secure correct backlash.

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Figure 7—Gear Tooth Contact Chart

DIFFERENTIAL & DRIVE GEAR INSTALLATION
(Key Numbers in Text Refer to Fig. 1)

1. Install bearing cups (4) over differential bearings (3), make certain that dowel pins are tight in bearing caps (5). Position differential case in carrier and install bearing caps (5). Turn nuts (14) on bearing cap studs (6) up tight and then back off sufficiently to allow adjusting rings (2) to turn.

2. Screw adjusting rings (2) into place in carrier (30) and tighten rings to seat bearings. Then back rings (2) off until differential turns freely but with no perceptible end play.

3. Adjust relative position of pinion gear (49) and bevel drive gear (10) so back ends of gear teeth are flush and back lash is within limits given in "Specifications" at end of this section. Position of bevel drive gear is adjusted by turning adjusting rings (2) in carrier (30) to relocate bearings (3). Left-hand adjusting ring must be tightened same amount as right-hand ring is loosened, or vice versa, to maintain correct adjustment of side bearings. Pinion gear is moved in or out by removing or adding shims (32) between carrier (30) and pinion cage (45). Refer to "Specifications" at end of this section for thickness of shims available. When cage (45) is finally assembled be sure oil holes are in line.

4. Paint bevel drive gear (10) teeth with a mixture of red lead and light oil. Turn bevel drive gear one complete revolution in direction of driving rotation. Examine tooth contact impressions and refer to "Gear Tooth Contact Chart," figure 7. Chart explains in detail method to follow to obtain correct tooth contact.

5. After completing adjustment of tooth contact and backlash, tighten side bearing cap stud nuts (16) fully and install adjusting ring locks (19) and bolts (18).

Backlash

Bevel gears are cut to have a definite amount of backlash which varies according to the pitch and operating conditions. This backlash is necessary for the safe and proper running of the gears. If gears are set too tightly they will be noisy, wear excessively, and possibly score the tooth surfaces. Use a dial indicator (fig. 8) to adjust bevel gear and pinion gear backlash. Refer to "Specifications" at end of this section for limits.

DIFFERENTIAL CARRIER INSTALLATION
(Key Numbers in Text Refer to Fig. 1)

1. Be sure lock wire is properly installed in all bolts in differential as required. Install differential carrier assembly including differential, pinion shaft and pinion cage in axle housing using new gasket (25) between carrier (30) and housing (1). Bushings (16) for bearing cap support studs (6) must be inserted in housing.

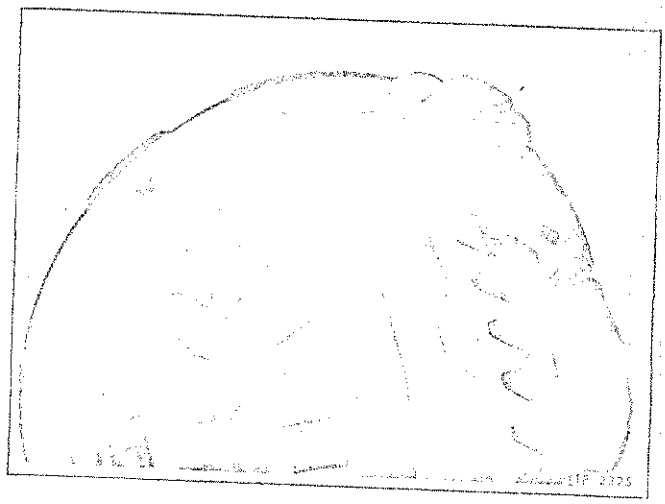

Figure 8—Typical Method of Checking Backlash

2. Insert locating bushing (16) in housing (1) over ends of bearing cap support studs (16). Then place new gasket (12) washer (13) and nuts (14) on in order. Tighten nuts (14) finger tight.

3. Screw nuts (27) on differential carrier studs (28) use lock washers (26) and tighten nuts (27) completely.

4. Tighten nuts (14) on support studs (16) completely after nuts (17) on carrier studs are tightened. Install breather nipple and cap on axle housing.

COMPLETING ASSEMBLY

1. Before installing axle shafts, (42) and (47) be sure that hubs have been removed, cleaned, inspected, bearings lubricated, replaced and adjusted as later directed in Hubs and Bearings (Sec. 19A, of this manual).

2. Install axle shaft (fig. 9) as previously directed under "Axle Shaft Installation" in this section.

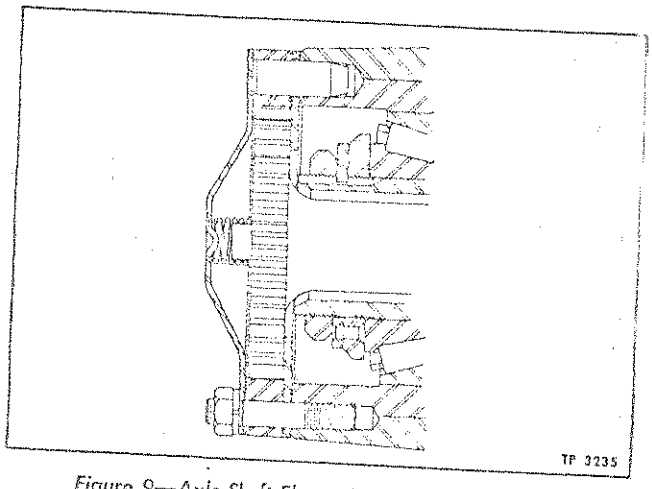

Figure 9—Axle Shaft Flange Installation at Rear Hub

REAR AXLE (EARLY TYPE)

3. Install axle assembly as previously directed under "Axle Assembly Installation" in this section.

LUBRICATION

Lubricants generally available for differentials thicken considerably after use due to oxidation and chemical reactions resulting from normal service conditions. This thickening seriously impairs lubricating qualities of lubricant and, if neglected, will finally result in semi-solids which will adhere to sides of housing and afford no lubrication whatever. It is essential, that, in addition to checking level of lubricant, its condition should be also considered. If there is any evidence of thickening differential should be drained and thoroughly cleaned.

Checking level and condition of lubricant frequently, together with periodic draining and refilling, is the best way to prevent lubricant thickening. Proper interval for refilling, as well as correct lubricant, is given in Lubrication (Sec. 13, of this manual).

SPECIFICATIONS

Type	Full Floating, Spiral Bevel
Drive	Angle Pinion
Housing	Hotchkiss
	Banjo Type
Differential	
Number of Pinions	4
GEAR RATIOS	
Standard	3-5/9:1
Optional	3-2/11:1
Optional	4-1/8:1
Differential Bearing Adjustment	Adjusting Rings (See Text)
Differential Case Run-out	.002"
Side Gear Thrust Washer Thickness	.125" - .121"
Pinion Thrust Washer Thickness	0.058" - .062"
Clearance Between	
Pinion and Spider	.004" - 0.007"
Differential Side Gear Hub and Spider	.002" - .006"
Side Gear Hub and Case	.009" - .016"
Drive Pinion Cage Assembly	
Inner Bearings	Straight Roller
Outer Bearings	Tapered Roller
Adjustment	Adjusting Nut (See Text)
Drive Pinion Backlash Adjustment	Shims
Shim Sizes Available 4 @	.005" - .010" - 0.020" - 0.030"
Pinion and Bevel Gear Adjustment	
Pinion and Bevel Gear Backlash	0.008" - .012"
Method of Adjustment	(See Text)
Axle Housing	
Distortion	1/16 Max.
Axle Shafts	
Drive Flange Run-out not to Exceed	.005"
Shaft Run-out at Center	1/16"
Number Splines	16
Backlash Between - Side Gear and Axle Shaft Splines	0.001" - 0.006"
Diameter - At Splined End	2.300" - 2.290"

SPECIAL TOOLS

Reference is made to special tools in this section. These tools, or their equivalent, are necessary and are recommended to more readily and efficiently accomplish certain service operations. The tools, however, are not supplied by GMC Truck & Coach Division. Names and addresses of vendors or manufacturers are shown as a reference, and since such vendors are the suppliers of these tools, information regarding availability, price, etc., should be obtained directly from them.

Tool No.	Name	Vendor Code
ABV-129	Pinion Bearing Torque Tester	ABV
CS-1047	Bearing Puller	

Vendor Code	Vendor Name	Address
ABV	K. R. Wilson Company	Buffalo, New York
CS	Curtiss Smith Mfg. Company	Pottstown, Pennsylvania

Rear Axle — Late Type

Contents of This Section

Related Subjects in Other Sections

Rear axle is full floating type. One-piece axle housing has cover welded to housing and housing bowl is offset toward right of vehicle. Drive pinion assembly is mounted at an angle as later illustrated in figure 1. Drive is transmitted from transmission angle drive unit through propeller shaft, spiral bevel gears, axle housing, and springs to vehicle underframe. Differential and pinion shaft assemblies both incorporate adjustments for bearings and gear tooth contact.

CONSTRUCTION

DIFFERENTIAL CARRIER

Differential assembly, pinion shaft and cage assembly, are mounted in differential carrier. After axle shafts have been removed, and propeller shaft has been disconnected, differential carrier can be removed for inspection and adjustment without removing axle housing from vehicle.

DIFFERENTIAL ASSEMBLY

Conventional four-pinion type differential is carried in two-piece case mounted on tapered roller bearings. Bevel drive gear is bolted to flanged half of differential case. Drive gear and pinion are furnished in matched lapped sets, and should always be installed as such to assure satisfactory operation.

Thrust washers are used between differential side gears and case and differential pinions and case. Each pinion contains an aluminum bronze bushing. When bushings become worn, pinions must be replaced. Differential case halves are held together with special bolts and slotted nuts, locked in place with lock wire.

DIFFERENTIAL SIDE BEARINGS

Differential case is supported in tapered roller bearings which take thrust as well as radial loads. Bearings are mounted in machined supports in differential carrier with thrust loads taken against adjusting rings threaded into carrier supports and bearing caps. Adjusting rings bear against bearing cups and are locked in position by adjusting ring locks bolted to each bearing cap.

Method of adjusting differential side bearings is explained under "Differential Case and Drive Gear Installation" later in this section.

DRIVE PINION & CAGE ASSEMBLY

Bevel drive pinion is installed at an angle in differential carrier. Pinion is straddle mounted in two opposed tapered roller bearings at outer end, and one straight roller bearing at inner end.

Tapered roller bearing cups are installed in pinion cage (fig. 1), separated by a machined shoulder in brake spider assembly.

Pinion bearings are adjusted on shaft by selecting correct size spacer as later described in this section.

Straight roller bearing at inner end of drive pinion, is secured in place with retainer and a bolt.

Shims of various thicknesses are used between bearing cage and differential carrier to adjust drive pinion tooth contact and gear backlash.

Pinion shaft and cage assembly cannot be removed from carrier until differential case assembly including drive gear has been removed from carrier.

REAR AXLE—LATE TYPE

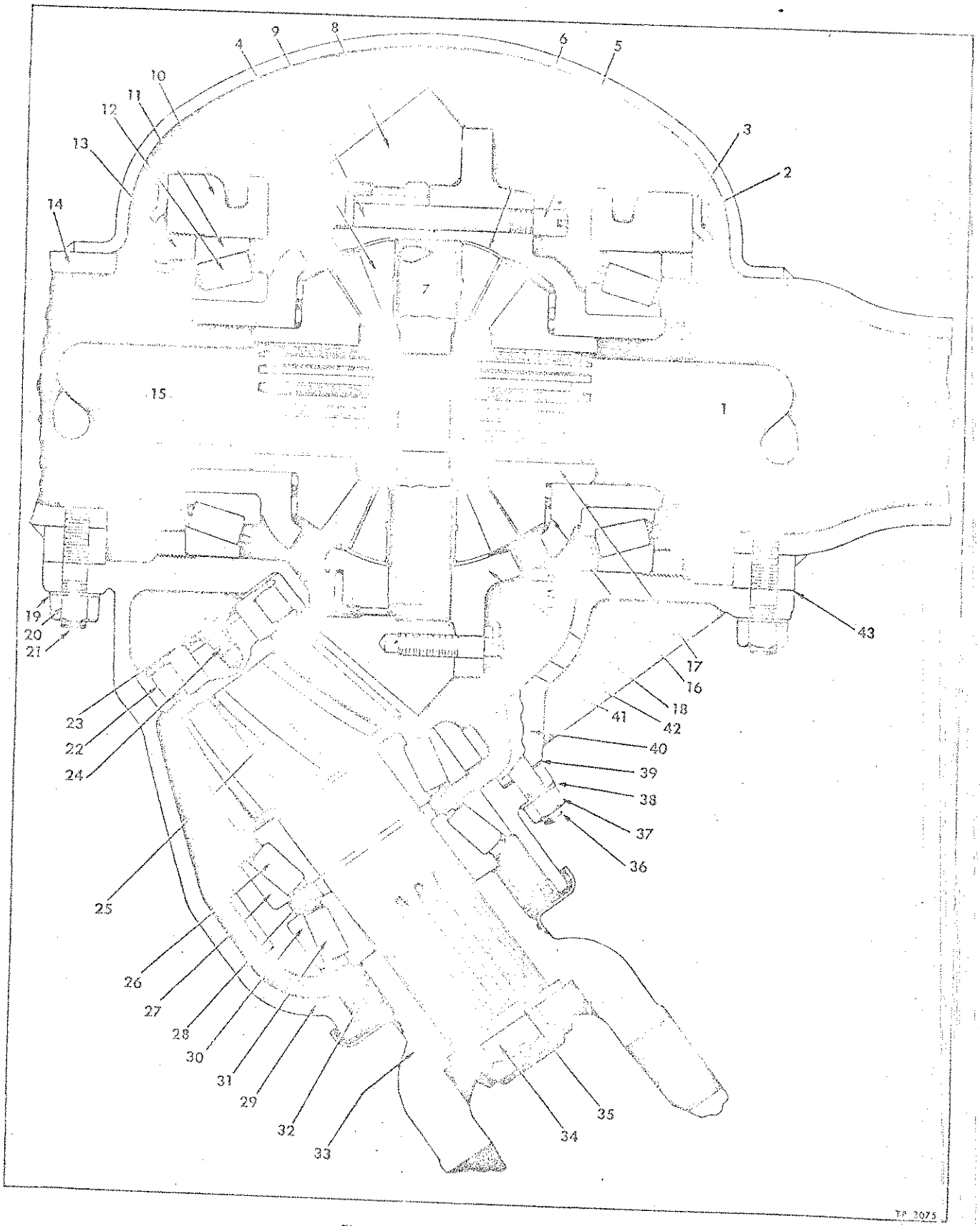

Figure 1—Sectional View of Rear Axle

REAR AXLE—LATE TYPE

1 Axle Shaft (Right-Hand)
2 Adjusting Ring Lock Bolt
3 Adjusting Ring Lock
4 Differential Pinion
5 Differential Case Bolt Nut
6 Differential Pinion Thrust Washer
7 Differential Spider
8 Drive Gear (Matched Assembly)
9 Differential Case Bolt
10 Differential Bearing Cap
11 Differential Side Bearing Cup
12 Differential Side Bearing Cone
13 Differential Bearing Adjusting Ring
14 Axle Housing Assembly
15 Axle Shaft (Left Hand)
16 Differential Side Gear Thrust Washer
17 Differential Side Gear
18 Differential Case Assembly
19 Lock Washer
20 Differential Carrier Stud Nut
21 Differential Carrier Stud
22 Drive Pinion Inner Bearing (Straight Roller)
23 Bearing Retainer
24 Pinion Bearing Retainer Bolt
25 Drive Pinion (Matched Assembly)
26 Drive Pinion Inner Bearing Cone (Tapered Roller)
27 Inner Bearing Cup
28 Drive Pinion Bearing Spacer (Shim)
29 Pinion Cage and Bearing Cup Assembly
30 Outer Bearing Cup
31 Drive Pinion Outer Bearing Cone (Tapered Roller)
32 Oil Seal Assembly
33 Propeller Shaft Flange
34 Drive Pinion Nut
35 Drive Pinion Nut Washer
36 Pinion Cage Stud
37 Pinion Cage Stud Nut
38 Lock Washer
39 Pinion Cage Shims (A.R.)
40 Differential Carrier Assembly
41 Drive Gear Bolt
42 Drive Gear Bolt Lock Wire
43 Differential Carrier Gasket

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Captions For Figure 1

AXLE SHAFT AND HOUSING

Axle shafts are full floating type. Drive flange at outer ends have external teeth which mesh with similar internal teeth on hub drive plate. Drive plate is doweled to hub with dowel pins and held in place together with plate cover with ten hub studs and nuts as later illustrated in figure 8.

Axle housing is one-piece design with differential located off center. Housing is equipped with removable outer end tubes which are threaded to accommodate wheel bearing adjusting nuts.

AXLE MAINTENANCE ON VEHICLE

At regular intervals, the rear axle should be inspected as follows:

1. Axle Shaft Cover Stud Nuts. Examine stud nuts and studs which secure drive plate covers on hubs for looseness and tighten nuts firmly if necessary. Use new lock washers under nuts if required.

2. Lubricant Leaks. Check pinion shaft oil seal and cover gasket, axle shaft plate and cover gaskets, and differential carrier gasket for leaks. Correct leaks by tightening bolts and stud nuts, or by replacing gaskets or oil seals.

3. U-Bolts. Check and tighten spring bolts. Examine axle for misalignment. This can be done by measuring from rear spring front bracket bolt to end of axle. A measurement taken between identical points at opposite end of axle should be the same as first measurement, if axle is properly aligned.

4. Axle Housing Check. If bent axle housing is suspected, check as directed under "Axle Repair" later in this section.

5. Lubricant. Check lubricant level at regular intervals. Add lubricant as required. Refer to Lubrication (Sec. 13 in this manual), for correct type of differential lubricant.

Housing should be kept filled to level of filler plug. Drain plug is at lowest point of housing.

AXLE SHAFT REPLACEMENT

AXLE SHAFT REMOVAL

1. Remove outer drive plate cover, cover spring and gasket. Insert 1/2"-13 cap screw in tapped hole in axle flange. Screw should be long enough to pull axle flange free from drive plate teeth. Withdraw axle shaft from housing.

2. If it is necessary to remove drive plate, do not remove axle shaft. Instead, use a suitable puller which will exert pressure on flange and may be attached to drive plate with three 1/2"-13 cap screws of sufficient length so drive plate teeth will clear flange teeth.

AXLE SHAFT INSTALLATION

1. Before axle shafts are installed, ascertain that hub bearings are in proper adjustment; then

insert drive plate dowel pins into place. Three gaskets are used at flange end of each axle shaft, namely between hub and drive plate, drive plate and drive ring, and between drive plate and plate cover.

2. Install over end of hub studs in sequence gasket, drive ring, gasket, drive plate and gasket; then dip splined end of axle in differential lubricant and insert shaft into hub. Align shaft splines with side gear splines, and flange teeth with drive plate teeth; then push shaft into place. Make certain the small spring between drive plate cover and shaft flange is located correctly on bosses of flange and cover.

3. Install nuts and new lock washers on studs; then tighten nuts alternately and firmly.

AXLE ASSEMBLY REPLACEMENT

AXLE ASSEMBLY REMOVAL

1. Remove drain plug and drain lubricant from axle housing. Loosen wheel stud nuts until nuts are finger tight.

2. Place jacks under axle housing, then raise vehicle. When rear of vehicle is supported with blocks placed in front of rear axle and jacks are removed, wheels should clear floor.

3. Remove jacks after blocks are securely in place under vehicle. Remove rear wheel stud nuts, then remove wheels.

4. Disconnect air lines at brake chambers.

5. Disconnect propeller shaft slip joint dust seal cap. Refer to propeller Shaft (Sec. 18 of this manual), for complete information on propeller shaft removal.

6. Loosen spring bolt nuts until nuts are finger tight.

7. Place a suitable dolly jack under axle housing. Be sure axle is cradled securely and properly balanced on jack. Raise axle assembly sufficiently to take weight of axle off springs.

8. Remove spring bracket side plates at rear end of both rear springs. Refer to Spring Suspension (Sec. 15 of this manual). Lower axle permitting springs to pivot on front shackle pins.

9. Remove spring bolts to free axle from springs.

10. Remove axle assembly by pulling dolly jack, supporting axle, out from under rear end of vehicle. Rear springs need not be removed from vehicle.

AXLE ASSEMBLY INSTALLATION

1. Carefully check, inspect and replace, as necessary, parts in propeller shaft universal joints, rear spring mountings, wheels and rear hubs. Each of these items is covered in detail, in its respective section elsewhere in this manual.

2. With rear axle completely assembled and supported on dolly jack, roll assembly into place under vehicle. Assemble propeller shaft slip joint. Align axle as required to accomplish assembly. Arrow markings on propeller shaft must be in alignment to assure assembling of universal joints in proper plane and balance. Refer to Propeller Shafts (Sec. 18 of this manual).

3. Position axle housing on springs and align center bolt head in recess provided in housing for center bolt. Position bolt spacer on top of housing, then install bolts in spacer and housing. Place spring retainer plate over ends of bolts and install nuts on bolts, finger tight.

4. Raise axle housing and align rear ends of spring in position. Install spring brackets as directed in Spring Suspension (Sec. 15 of this manual).

5. Lower dolly jack, then tighten bolt nuts firmly.

6. Connect brake air lines at brake chambers; refer to Brakes (Sec. 4B of this manual).

7. Install rear wheels and tighten stud nuts. Refer to Wheels and Tires (Sec. 19B of this manual).

8. Raise dolly jack under axle housing sufficiently to remove blocks which support vehicle, then lower jack and remove from under vehicle.

9. Be sure that axle housing is filled to correct level with proper lubricant and filler plug installed. Refer to Lubrication (Sec. 13 of this manual).

REAR AXLE REPAIR

The following instructions provide procedures for removal, complete disassembly, cleaning, inspection, repair and assembly of rear axle.

Axle shafts and differential carrier assembly may be removed from axle housing for repair or replacement without removing entire axle assembly from the vehicle. For a complete inspection and rebuilding of the entire assembly, it is recommended that rear axle be removed from the vehicle.

AXLE HOUSING CHECK (Before Removal)

At regular intervals, or when it is suspected that rear axle is bent, a check should be made

by the following method. This check can be made before the axle assembly is removed from the vehicle, and in that manner determine the extent of repairs required. The check is made with conventional front end alignment camber and toe-in equipment.

1. Check hub bearing adjustment and adjust bearings if required. Refer to Hubs and Bearings (Sec. 19A of this manual). Check rear wheels for run-out or "wobble" in the following manner:

a. Place vehicle on smooth level floor; then raise rear axle with a jack and place supports under each side of axle housing.

b. Make certain that wheels are mounted solidly on hubs and that wheel nuts are tightened firmly. Position a spring type scriber or marker (same type used to mark center of tire treads when checking front end alignment), at right angle to rear outside wheel rim. Point of scribe should be placed 1/8" away from wheel rim.

c. Revolve wheel slowly, and at the same time, note if rim of wheel contacts point of scriber or, if gap between scriber point and rim increases or diminishes. If run-out exceeds 3/32 inch (new limits), wheel should be replaced with one that does not exceed new limits. Perform check on both rear wheels.

2. Lower wheels to floor. Place a conventional camber gauge on rim of wheel. Note reading, if reading exceeds 0 degree, plus or minus 1/4 degree, axle housing is bent on that side. Repeat check on opposite wheel and note reading on camber gauge. If reading exceeds 0 degree, plus or minus 1/4 degree, that side is also bent.

3. Place a conventional toe-in gauge between inner tires in front of rear axle under vehicle close to bottom side of springs. Note reading at each end of instrument; then carefully roll vehicle forward until instrument is close to bottom side of springs at rear of vehicle. Again note readings at ends of instrument, if second reading exceeds the first by more than 1/4 degree, the side (right or left) of the axle on which the variation exists, is bent forward or backward as denoted by the reading.

AXLE DISASSEMBLY

(Key Numbers in Text Refer to Fig. 1)

Before and during disassembly operations, a preliminary inspection and check of all adjustments should be made to determine repairs required. Proceed as follows:

1. Disconnect propeller shaft universal joint at drive pinion flange and remove axle assembly from vehicle as previously directed under "Axle Assembly Replacement" in this section.

2. Perform a visual check on the exterior of axle housing for leaks, damage, cracks, etc., which are usually detected before axle housing is cleaned. Note all evident conditions to assist in the repair of axle assembly. After inspection is completed, clean exterior of axle housing thoroughly with a suitable cleaning fluid and a stiff bristled brush, or use steam cleaning.

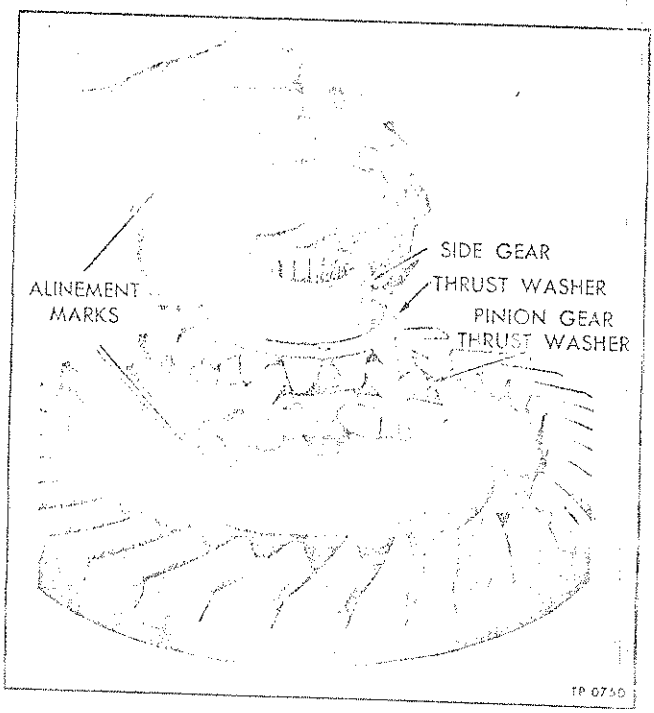

Figure 2—Typical Differential Case Showing Alignment Marks

3. After differential carrier assembly is removed from housing, check drive pinion for end play and note if end play is evident. Check differential case assembly run-out and backlash before removal of differential and make note of same for later reference during repair.

4. At this point hubs should be removed, cleaned, inspected, lubricated, replaced and adjusted as outlined in Hubs and Bearings (Sec. 19A in this manual).

DIFFERENTIAL CARRIER REMOVAL (Fig. 1)

1. Remove axle shafts as previously instructed under "Axle Shaft Replacement" in this section.

2. Remove drain plug and drain lubricant from housing while loosening differential carrier stud nuts.

3. Remove stud nuts and lock washers from housing to carrier studs.

4. Be certain that differential carrier is supported solidly, then proceed to pull complete carrier assembly out of housing.

DIFFERENTIAL REMOVAL FROM CARRIER

1. Remove lock wire from bolts (2) which lock adjusting rings (13).

2. Remove nuts from differential side bearing

REAR AXLE—LATE TYPE

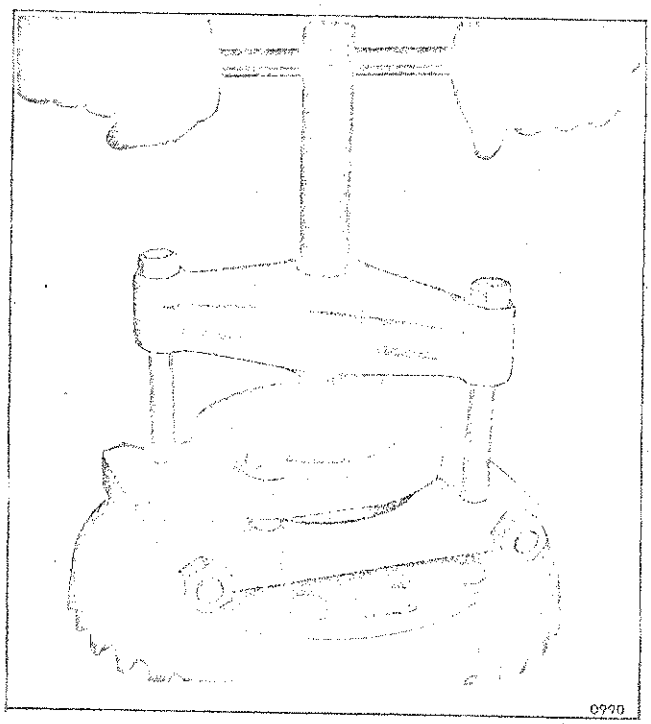

Figure 3—Removal of Differential Side Bearings (Tool No. CS-1047)

cap studs. Make certain that bearing caps and carrier are marked before removal; then remove side bearing caps (10) and cups (11), and lift out differential assembly including drive gear (8), side bearings (12). Remove side bearing adjusting rings (13).

DIFFERENTIAL CASE DISASSEMBLY

1. Mark both halves of case so halves may be reassembled in original positions (fig. 2).

2. Remove side bearings (33) from each half of case, using special bearing puller CS-1047 (fig. 3).

3. Remove lock wire and nuts (5) from the bolts (9) which hold the two halves of differential case (18) together; then separate case (18).

4. Remove side gears (17), thrust washers (16) and (6), spider (7) and pinions (4).

5. If either drive gear (8) or pinion (25) are worn or damaged, both must be replaced as a matched set. Never replace pinion or ring gear alone.

PINION CAGE REMOVAL AND DISASSEMBLY (Fig. 1).

1. Mark pinion cage (29) and differential carrier (40) so parts can be reassembled in the same relative position. Remove nuts (37) and lock washers (38) which secure cage (29) on carrier (40).

2. Install and tighten puller screws alternately to pull cage (29) out of carrier; then note quantity and remove shim (39) pack from carrier. Tie shims (39) together so same shim (39) pack may be used at reassembly.

3. Remove bolt (24) and retainer (25) which secure inner bearing (22) on drive pinion (25); then remove inner bearing (22) from drive pinion (25) with a suitable puller.

4. Clamp flange (33) in vise equipped with padded jaws. Remove cotter pin and nut (34) from drive pinion (25).

5. Place cage and drive pinion assembly in an arbor press and press drive pinion out of flange (33) and pinion cage. Outer bearing (31) will remain in pinion cage (29).

6. Remove shim (28) from drive pinion (25). Use special bearing puller (CS-1047) and remove inner bearing (26) from drive pinion (25); then remove oil seal (32). Inspect bearing cups (27) and (30). If bearing cups must be removed from cage (29), use brass drift and carefully drive cups out of pinion cage.

CLEANING, INSPECTION, AND REPAIR

CLEANING BEARINGS

1. Immerse differential and drive pinion bearings in gasoline, kerosene, or other suitable cleaning fluid. Leave bearings in fluid long enough so fluid will dissolve and loosen old lubricant. After bearings have been soaked in fluid a sufficient length of time, bearings should be alternately slushed up and down and spun slowly below the surface of liquid to remove old lubricant.

2. Remove bearing from fluid, then strike large side of bearing flat against wooden block to jar loose heavy and larger particles of lubricant. Repeat until bearings are thoroughly clean.

3. Rinse bearings out in clean fluid, then blow bearings dry with compressed air. CAUTION: Do not spin bearings while blowing them dry with compressed air. After bearings have been inspected as later described in this section of the manual, and bearings are going to be used, dip bearings in differential lubricant recommended in Lubrication (Sec. 13 of this manual), and wrap in clean cloth or paper until needed.

CLEANING PARTS

1. Immerse all parts in suitable cleaning fluid and clean parts thoroughly. Use a stiff bristle brush as required to assure removal of any accumulation of old lubricant, etc., which may be evident. Remove particles of gaskets which may adhere to mating faces of axle housing, differential carrier, cover oil seal retainer, hubs and axle shaft flanges. Clean lubricant channels in pinion cage and differential carrier as required.

Clean housing breather. Make certain that axle housing is thoroughly cleaned.

INSPECTION

Whenever available, the Magna Flux Method should be used on all steel parts, except ball and roller bearing. This method is especially suited for inspection of ground or highly finished surfaces for wear and cracks which otherwise would not be visible to the naked eye.

INSPECTION OPERATIONS

1. Bearings. Rotate each bearing slowly, and at the same time examine bearing for roughness, damage, defects, or wear. Note condition of bearing cage and replace bearing if cage is damaged or if any of the conditions previously noted are evident.

2. Gears. Examine drive gear and drive pinion, differential side gears closely for damaged teeth, worn spots in surface hardening and distortion. Examine bushings in differential pinions for grooves, or excessive wear and check fit of gears on spider. Refer to "Specifications" later in this section for limits. Inspect drive gear rivets for looseness, replace loose rivets. Check radial clearances between differential side gears and differential pinions on spider. Refer to "Specifications" at end of this section for limits.

3. Differential Case. Inspect differential case assembly for cracks, distortion or damage, if case is in good condition, thoroughly clean case and cover; then assemble case with bolts and mount in lathe centers or "V" block stand. If lathe is not available, install differential side bearings and mount case in differential carrier as directed under "Differential and Drive Gear Installation" later in this section. Install dial indicator and check differential case run-out. Refer to "Specifications" at end of this section, for run-out limits. Whenever run-out exceeds limits differential case run-out may be corrected as later described under "Repair" in this section.

4. Axle Shafts. Examine splined end of axle shaft for twisted or cracked splines, twisted shaft, and damaged teeth on flange. If any of above conditions are evident, install new axle shafts.

5. Axle Shaft and Flange Run-out. Install axle shaft assembly in lathe centers or "V" blocks and check shaft run-out with dial indicator, if run-out exceeds limits listed under "Specifications at end of this section, discard axle shaft. Position dial indicator so that indicator shaft end contacts inner surface of flange near outer edge of flange and check flange run-out. Whenever run-out exceeds limits listed under "Specifications" at end of this section, discard axle shaft.

AXLE HOUSING INSPECTION

1. Thoroughly clean inside of housing as well as outer ends. Temporarily install wheel hubs. Refer to Hubs and Bearings (Sec. 19A of this manual), and Lubrication (Sec. 13 of this manual).

2. Adjust wheel bearing nuts so that hubs will just turn; however, do not lock adjustment at this time. Install axle shafts, dowels and nuts; then tighten nuts firmly. NOTE: Axle shafts should be

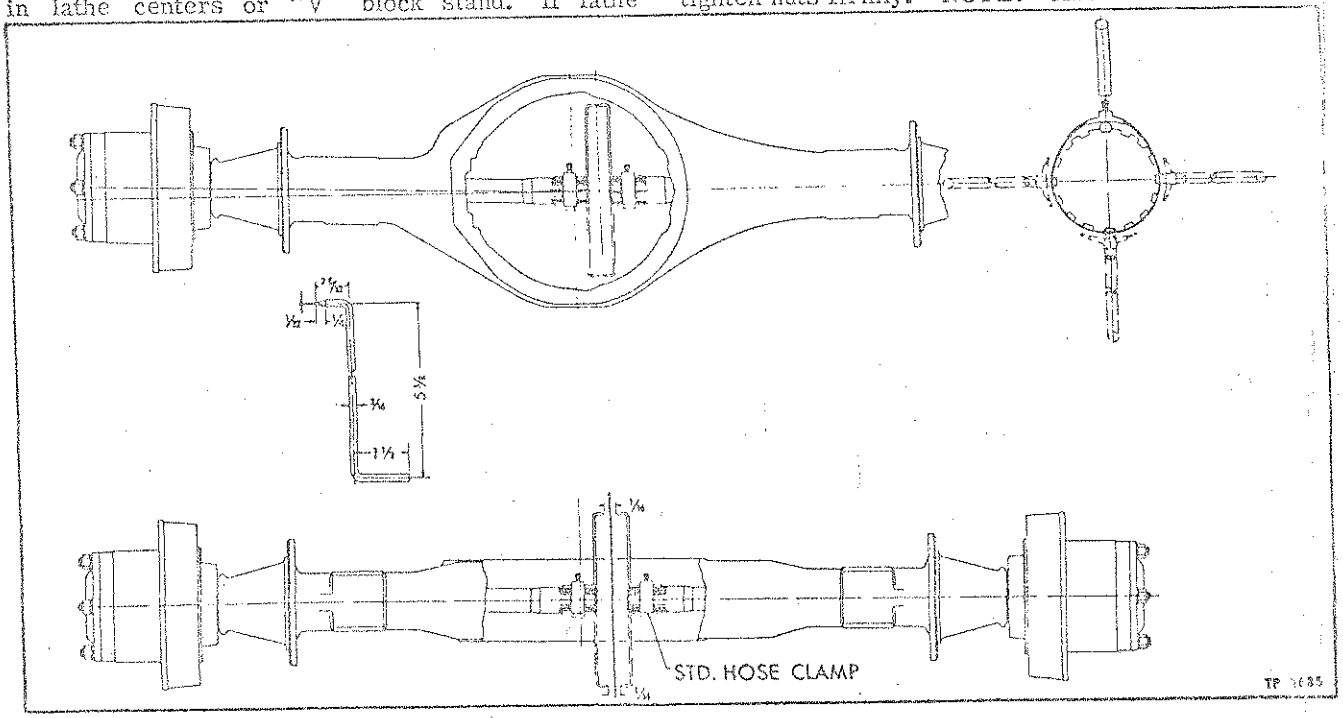

Figure 4—Housing Alignment Check

REAR AXLE—LATE TYPE

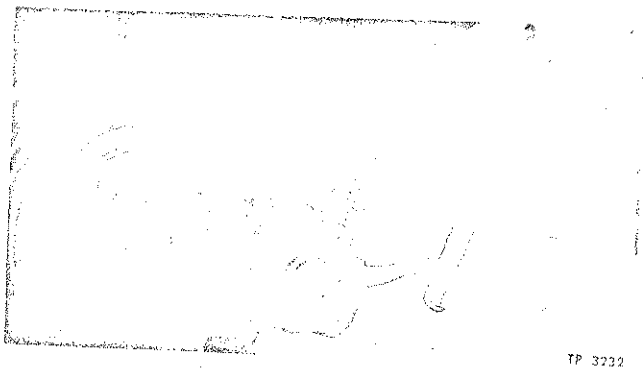

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Figure 5—Typical Pinion Bearing Adjustment Test (Tool No. ABV-129)

inspected as previously described under "Inspection Operations" in this section, before installation.

3. Indicators, as shown in figure 4, may be made locally from welding or drill rod (3/16" diameter) to dimensions shown. Make certain that burrs on axle shaft splines have been removed. Install indicators in place as shown in figure 4. Radiator hose clamps of suitable diameter may be used to secure indicators in position.

4. Each indicator must be positioned at right angle to its respective axle shaft after it is secured in place. Both indicators must be in alignment with each other. There should be a slight gap between the points as shown in figure 4. Insert a feeler gauge or measure gap between the indicator points, and make note of this dimension.

5. Place both indicators in alignment, then rotate both shafts simultaneously. Make a check of the gap dimensions between the indicators at four points 90 degrees apart, as shown in figure 4. If the gap at each point exceeds original predetermined gap by more than 1/16," axle housing is bent at various points and should be straightened or replaced.

OIL SEAL INSPECTION

Replacement of spring loaded oil seal whenever unit is disassembled is more economical than premature overhaul to replace these parts at a future time. Further, loss of lubricant through a worn seal may result in failure of other parts, such as gears and bearings.

Handle seals carefully, particularly when seals are being installed. Cutting, scratching or curling under of lip of seal seriously impairs efficiency of seal. Use of Permatex or equivalent around outer diameter of seal is recommended to insure against leakage at that point.

REPAIR

Differential Case. Excessive run-out on differential case may be corrected by machining flange on gear side of case. Remove sufficient metal from gear face of flange on differential case to correct excessive run-out. The metal must be cut on a true plane removing just enough metal to bring run-out within limits listed under "Specifications" at end of this section. After differential case has been machined, remove burrs and clean case assembly thoroughly.

Propeller Shaft Flange. Whenever inspection indicates that exterior surface of flange which contacts oil seal is corroded or pitted, the condition may be corrected by cleaning and polishing surface with a suitable abrasive cloth. If cleaning and polishing surface of flange does not clear up the condition, discard flange and install new parts.

REASSEMBLY

(Key Numbers in Text Refer to Fig. 1)

Before the axle is reassembled, make certain that all parts have been thoroughly cleaned, and that a thin coating of differential lubricant specified in Lubrication (Sec. 13 of this manual), is applied on all thrust and bearing surfaces to prevent scoring of parts when vehicle is first placed in service.

New lock washers, gaskets, and oil seals are recommended throughout during reassembly of axle. Make certain that all threads on bolts, screws, etc., are in good condition before they are installed.

Adjustments must be carefully made to insure efficient and continuous operation.

DRIVE PINION & CAGE REASSEMBLY (Figs. 1 and 5)

1. Press bearing cups (27) and (30), into pinion cage (29) if cups have been removed.

2. Press bearing assembly (26) on drive pinion (25) with widest part of bearing cone (26) toward gear teeth. Make certain that bearing (26) seats solidly against gear teeth.

3. Install bearing spacer (28) over splined end of drive pinion (25). Refer to "Specifications" at end of this section, for sizes available. Insert splined end of drive pinion (25) into pinion cage (29); then install outer bearing (31) in cage (29) on top of spacer (28).

4. Secure a short piece or pipe of tubing which will fit over splined end of drive pinion (25), and of sufficient diameter so that it will bear on inner race of outer pinion bearing (31). Pipe should be short enough so that after installation onto drive pinion is made, washer (35) can be placed on top of pipe and drive pinion nut (34) screwed onto drive pinion (25).

5. Tighten nut (34), 700 to 900 foot pounds torque with a torque wrench which will obtain a bearing adjustment of .000" to .002" tight when

correct spacer is used. Bearing adjustment may be checked with torque wrench (fig. 5) and reading obtained, should be 6 to 8 inch pounds torque. If torque wrench reading exceeds limits, install thicker spacer (28). When reading is below limits, install thinner spacer (28).

6. Install bearing (22) on inner end of drive pinion (25) and lock in place with new retainer (23) and bolt (24).

7. After bearing adjustment is completed; remove nut, washer and pipe or tubing from drive pinion (25); then install oil seal (32) in pinion cage (29).

8. Make certain that splines on pinion (25) and in flange (33) are cleaned; then install flange (33) and dust slinger on drive pinion (25). Attach flange with nut (34). Tighten nut (34) with torque wrench 700 to 900 foot pounds torque. Align cotter pin hole in drive pinion (25) with slots in nut (34) and install new cotter pin full size of hole.

9. Dip end of pinion with roller bearing (22) in differential lubricant. Install cage assembly (29) in differential carrier (40) using same number and thickness of shims (39) between cage flange and carrier as were removed. Be certain oil holes in cage assembly (29) and shims (39), index with those in carrier (40) to assure proper lubrication. Install nuts (37), and new lock washers (38) on studs (36). Tighten nuts firmly.

DIFFERENTIAL CASE REASSEMBLY (Fig. 1)

1. Before assembling differential case, ascertain that differential case run-out has been checked as previously described in this section under "Inspection Operations."

2. Dip side gears (17), pinion gears (4), thrust washers (6 and 16) and spider (7) in differential lubricant; then permit excess lubricant to drain off parts. Install pinions (4) and thrust washers (6) on spider (7). Install washers (16) on hubs of gears (17). Place one gear (17) and washer (16) in left-hand section of case (18), position spider assembly on top of gear (17), then install other gear (17) and washer (16) on top of spider assembly.

3. Place right-hand section of case (18) in position on top of left section of case. Alignment marks (fig. 3) on sections of case must register correctly to be certain that case is assembled in original relative position. Insert bolts (9) into left-hand section of case (18) and through right-hand section; then install nuts (5) on bolts (9) and tighten nuts firmly. While nuts are being tightened, align slots in nuts (5) with holes in bolts (9) so that lock wire can be installed to lock nuts in place after nuts (5) are tightened. Insert lock wire through bolts, draw wire taut and secure ends of wire together.

4. Assemble drive gear (8) onto differential case (18), install bolts (41) which are used to attach gear (8) to case (18), then tighten bolts (41) securely and insert lock wire (42) through heads of bolts (41) in such a manner so that lock wire will tighten if bolts loosen.

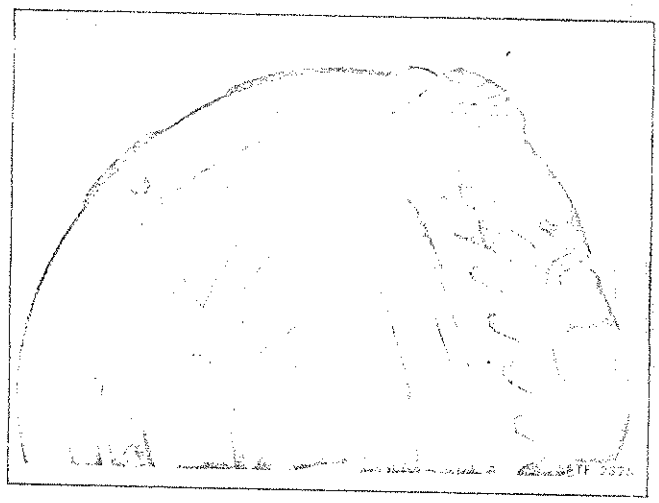


Figure 6—Typical Method of Checking Backlash

5. Install bearings (12) on case hubs (18) with a suitable piece of tubing which will bear on inner race of bearing (12). Make certain that bearings seat solidly on hubs of case.

DIFFERENTIAL CASE DRIVE GEAR INSTALLATION (Fig. 1)

1. Install bearing cups (11) over differential bearings (12). Make certain that dowel pins are tight in bearing caps (10). Position differential case in carrier and install bearing caps (10). Turn nuts on bearing cap studs up tight and then back off sufficiently to allow adjusting rings (13) to turn.

2. Screw adjusting rings (13) into place in carrier (40) and tighten rings to seat bearings. Then back rings (13) off until differential turns freely but with no perceptible end play.

3. Adjust relative position of pinion gear (25) and drive gear (8) so back ends of gear teeth are flush and back lash is within limits given in "Specifications" at end of this section. Position of drive gear is adjusted by turning adjusting rings (13) in carrier (40) to relocate bearings (12). Left-hand adjusting ring must be tightened same amount as right-hand ring is loosened, or vice versa, to maintain correct adjustment of side bearings. Pinion gear is moved in or out by removing or adding shims (39) between carrier (40) and pinion cage (29). Refer to "Specifications" at end of this section for thickness of shims available. When cage (29) is finally assembled be sure oil holes are in line.

4. Paint drive gear (8) teeth with a mixture of red lead and light oil. Turn drive gear one

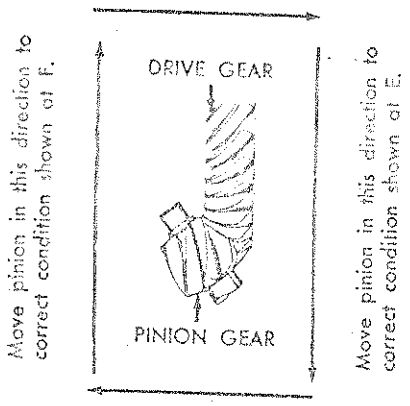
REAR AXLE—LATE TYPE

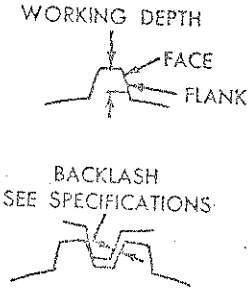
INSTRUCTIONS

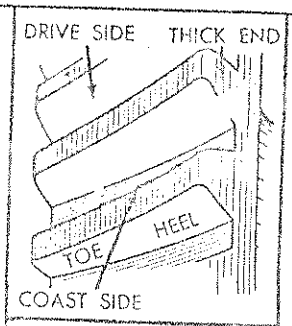
1—Install pinion with pinion bearings adjusted for proper end-play. Install differential assembly so that with bearings properly adjusted there will be sufficient backlash to permit final adjustment of pinion position to bring heels of teeth flush.

2—Paint three or four teeth of drive gear with red lead or Prussian blue and rotate pinion until bevel gear makes complete revolution.

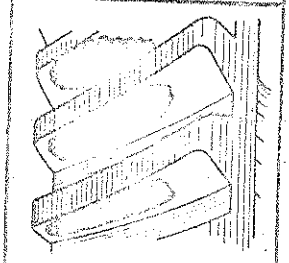
3—Vary position of pinion and drive gear as per chart until proper tooth contact is obtained. Be sure that sufficient backlash has been allowed so that drive gear can be completely revolved without any highspots being felt.



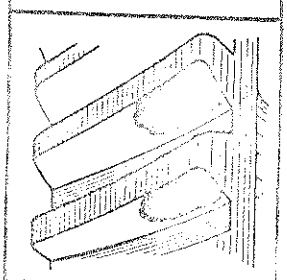




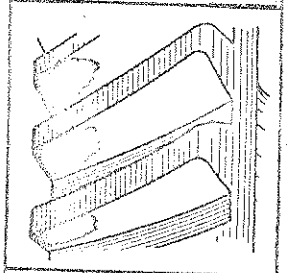
A—Check adjustments on drive side of drive gear tooth. Coast side will then automatically show a desirable tooth contact when adjusted correctly.



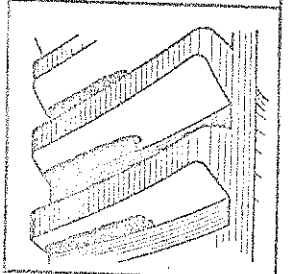
B—Shows correct tooth contact.



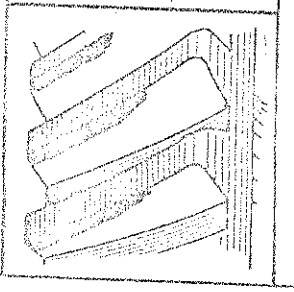
C—Shows short contact at heel. To correct, move drive gear toward pinion. Then move pinion away from drive gear to again secure correct blacklash.



D—Shows short contact at toe. To correct, move drive gear away from pinion. Then move pinion toward drive gear to again secure correct backlash.



E—Shows heavy contact on flank or lower portion of tooth. To correct, move pinion away from drive gear until contact comes to full working depth of gear tooth without breaking contact at flank. Then move drive gear toward pinion to secure correct backlash.



F—Shows heavy contact on face or upper portion of tooth. To correct, move pinion toward drive gear until contact covers flank of tooth without breaking contact at face. Then move drive gear away from pinion to secure correct backlash.

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Figure 7—Gear Tooth Contact Chart

complete revolution in direction of driving rotation. Examine tooth contact impressions and refer to "Gear Tooth Contact Chart," figure 7. Chart explains in detail method to follow to obtain correct tooth contact.

5. After completing adjustment of tooth contact and backlash, (fig. 6) tighten side bearing cap stud nuts fully and install adjusting ring locks (3) and bolts (2).

Backlash

Bevel gears are cut to have a definite amount of backlash which varies according to the pitch and operating conditions. This backlash is necessary for the safe and proper running of the gears. If gears are set too tightly they will be noisy, wear excessively, and possibly score the tooth surfaces. Use a dial indicator (fig. 6) to adjust bevel drive gear and pinion gear backlash. Refer to "Specifications" at end of this section for limits.

DIFFERENTIAL CARRIER INSTALLATION

1. Be certain flanges of carrier (40) and housing (14) are clean and smooth.

2. Place a new gasket (43) on housing.

3. Install carrier in housing and install new lock washers (19) and nuts (20), tighten nuts (20) up evenly to prevent distortion of flange.

4. Connect propeller shaft at pinion flange. Refer to Propeller Shafts (Sec. 18 of this manual).

5. Make certain that drain plug is installed and tightened firmly. Fill axle housing to proper level using correct lubricant as specified in Lubrication (Sec. 13 of this manual). Be sure to replace and tighten filler plug.

COMPLETING ASSEMBLY

1. Before installing axle shafts, (1) and (15), be sure that hubs have been removed, cleaned, inspected, bearings lubricated, replaced and adjusted as later directed in Hubs and Bearings (Sec. 19A of this manual).

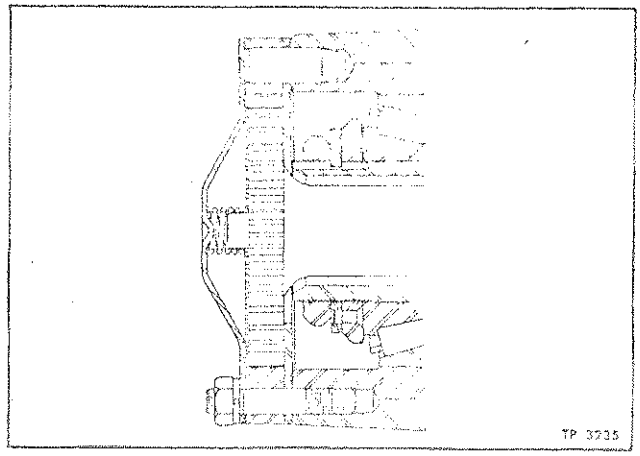


Figure 8—Axle Shaft Flange Installation

2. Install axle shaft (fig. 8) as previously directed under "Axle Shaft Installation" in this section.

3. Install axle assembly as previously directed under "Axle Assembly Installation" in this section.

LUBRICATION

Lubricants generally available for differentials thicken considerably after use due to oxidation and chemical reactions resulting from normal service conditions. This thickening seriously impairs lubricating qualities of lubricant and, if neglected, will finally result in semi-solids which will adhere to sides of housing and afford no lubrication whatever. It is essential, that, in addition to checking level of lubricant, its condition should be also considered. If there is any evidence of thickening differential should be drained and thorough cleaned.

Checking level and condition of lubricant frequently, together with periodic draining and refilling, is the best way to prevent lubricant thickening. Proper interval for refilling, as well as correct lubricant, is given in Lubrication (Sec. 13 of this manual).

SPECIAL TOOLS

Reference is made to special tools in this section. These tools, or their equivalent, are necessary and are recommended to more readily and efficiently accomplish certain service operations. The tools, however are not supplied by GMC Truck & Coach Division. Names and addresses of vendors or manufacturers are shown as a reference, and since such vendors are the suppliers of these tools, information regarding availability, price, etc., should be obtained directly from them.

Tool No.	Name	Vendor Code
ABV-129	Pinion Bearing Torque Tester	ABV
CS-1047	Bearing Puller	CS

Vendor Code	Name and Address
ABV	K. R. Wilson Co. - Buffalo, N. Y.
CS	Curtiss Smith Mfg. Co. - Pottstown, Pa.

REAR AXLE—LATE TYPE

SPECIFICATIONS

(New Limits)

Type	Late Type
Type	Full Floating Spiral Bevel Angle Pinion
Drive	Hotchkiss
Housing	Banjo Type
Differential	
Number of Pinions	4
GEAR RATIOS	
Standard	3-5/9:1
Optional	3-2/11:1
Optional	4-1/8:1
Differential Bearing Adjustment	Adjusting Rings (See Text)
Differential Case Run-out	.002 Max.
Side Gear Thrust Washer Thickness	0.121" - .125"
Pinion Thrust Washer Thickness	0.050" - .062"
Clearance Between	
Pinion and Spider	0.003" - .007"
Side Gear Hub and Case	0.008" - .012"
Drive Pinion Cage Assembly	
Inner Bearing	Straight Roller
Outer Bearings	Tapered Roller
Adjustment	Spacers (See Text)
Drive Pinion Spacers (Shims)	.375" - .427" (.002" Steps)
Drive Pinion Backlash Adjustment	Shims
Shim Sizes Available 3 @	.005" - .010" - .020"
Pinion & Bevel Gear Adjustment	
Pinion and Bevel Gear Backlash	0.008" - .012"
Method of Adjustment	(See Text)
Axle Housing	
Distortion	1/16" Max.
Axle Shafts	
Drive Flange Run-out Not to Exceed	0.005"
Shaft Run-out at Center	1/16"
Number of Splines	16
Backlash Between -	
Side Gear and Axle Shaft Splines	0.001" - .005"
Diameter - At Splined End	2.372" - 2.377"

Body

Contents of This Section

Related Subjects in Other Sections

GENERAL MAINTENANCE

The body comprises the main structure of the vehicle. Unlike conventional motor cars and trucks, separate frame is not used, all units such as power plant, running gear, steering system, etc., being attached directly to body. Low center of gravity, reduction of weight, and flexibility of structure are achieved through this design without sacrifice of strength.

Since separate frame is not used, all road shock, driving and braking stresses, etc., are absorbed by body framing and outer panels. A small amount of twist or undulation occurs in body, as complete rigidity of the structure is not desirable. It is therefore important that body be regularly inspected for loose rivets and bolts.

Entire vehicle should be regularly inspected for condition of paint and for corrosion damage, with particular attention given to underside. Inspection should be made more frequently in freezing weather due to the corrosive effects of road de-icing materials (salt, calcium chloride, etc.) on metal. If inspection discloses any evidences of corrosion, paint failure, or bare metal, corrective measures as outlined under "Painting" (later in this section) should be immediately employed.

EXTERIOR MAINTENANCE

Both painted surfaces and polished side panels should be protected by a coating of wax, applied at regular intervals. Periods between applications should be sufficiently short to assure continuous protection of the finish. Any good body wax can be used for both painted and polished surfaces. Wax should be applied immediately after coach has been cleaned, by spraying or other means. Wax should be rubbed down either with a lamb's wool polishing wheel or by hand.

Both polished and painted surfaces can be cleaned with mild soap and water. When necessary to remove previous wax coatings, gasoline or similar solvents meeting local fire and health regulations may be employed.

Hard, alumilite finish on fluted side panels is produced by an electrochemical process. Alumilite coating is abrasion-resistant and may be cleaned, if necessary, with a mild abrasive cleaner. However, alumilite like other aluminum, is attacked by many acids and most alkalies. Consequently, considerable care should be taken in the selection of chemical cleaners. Numerous joints in side panels make use of even inhibited alkaline cleaners inadvisable, due to difficulty in removing all traces of cleaner.

INTERIOR MAINTENANCE

Cleaning Painted Surfaces

Clean surface with cloth dampened in gasoline, then rub with polishing compound. Rub with clean cloth until original finish is restored.

Cleaning Rubber

Use soap and water for cleaning rubber. Do not use gasoline, since gasoline attacks rubber.

BODY

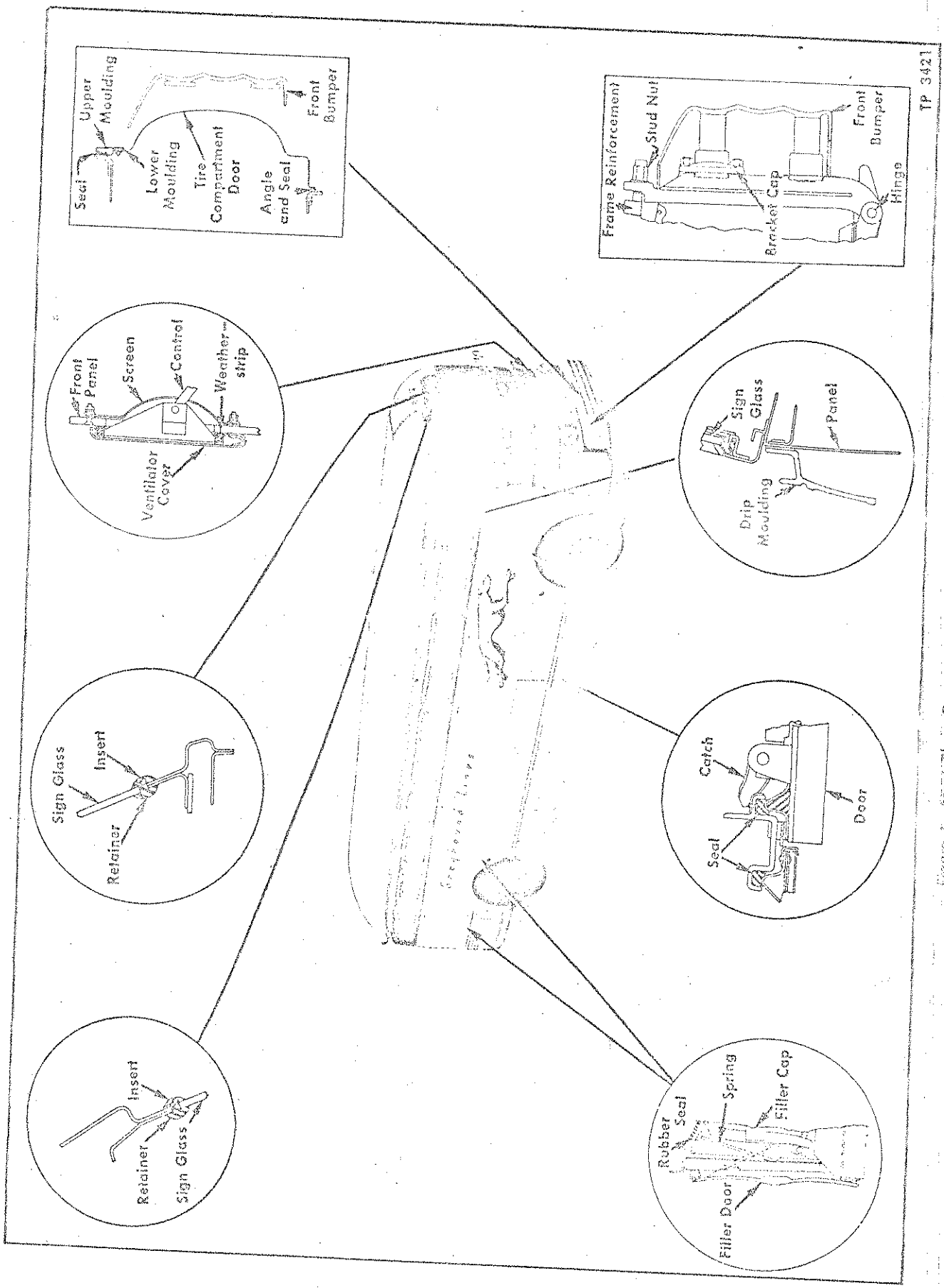


Figure 1—Steel Three Quarter View Showing Construction

Figure 1—Front Three-Quarter View ving Construction

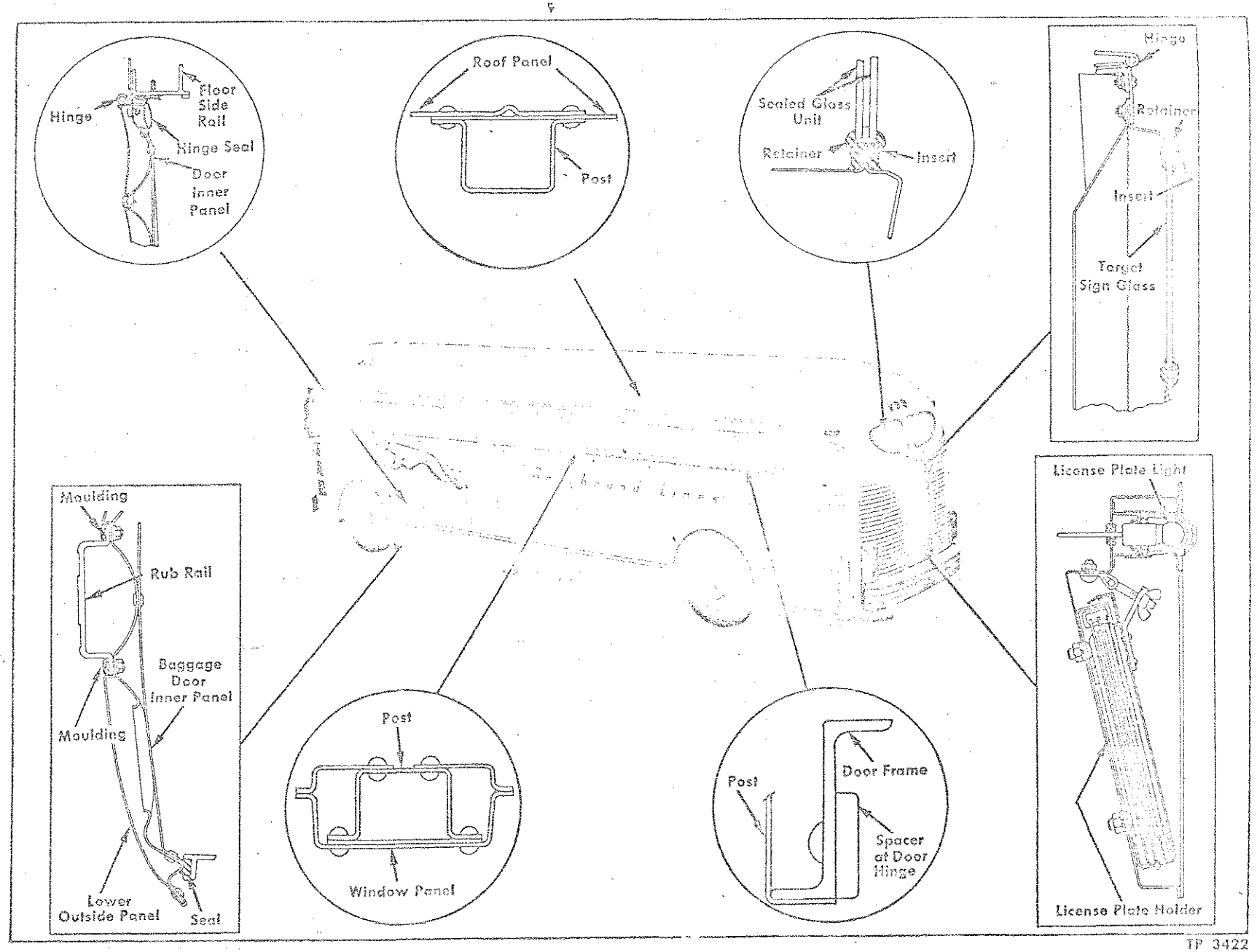


Figure 2—Rear Three-Quarter View Showing Construction

BODY

Cleaning Metal

Use paint thinner or any good metal polishing compound for unpainted metal surfaces.

Cleaning Window Glass

Use any standard cleaner which does not attack paint. Apply cleaning solution, then rub with cloth dampened in water. Rub with clean cheese cloth until dry.

Cleaning Light Fixture Glass

Semi-frosted glass can be cleaned with commercial muriatic (hydrochloric) acid. Remove glass from coach since acid will damage adjacent parts. Protect hands with rubber gloves and wear goggles. Pour a small amount of acid on glass and rub gently with a clean cloth. Rinse with water and dry before installing in coach.

BODY STRUCTURE

Body and integral underframe are of all-metal construction. Underframe and body are built as a unit forming, in effect, a girder-type structure.

Body is composed of underframe, sides, front end, rear end, floor, and roof. Baggage racks are formed by underframe, floor and sides; inside package racks are suspended from carlines and upper side posts. Engine is mounted in rear of vehicle, supported by roof structure. Some details of body construction are shown in figures 1 and 2.

UNDERFRAMING

Body underframing consists of longitudinal members over front and rear axles, to which running gear is attached. Two longitudinal channels, which form part of front longitudinal members, are also attached to rear longitudinal members. Baggage compartment bulkheads and compartment bulkheads and compartment floor are attached to longitudinal channels. Seat floor is supported by longitudinal members, bulkheads, and floor side rails.

BODY SIDES

Body side is composed of posts, plain side panels, window panels, rub rails, brackets and reinforcements. Sides are attached to floor side rails, bulkheads, and baggage compartment floor. Outer fluted panels are attached to plain side panels. Side includes several small doors for access to batteries, surge tanks and fuel filler caps. Baggage compartment doors are also included, being hinged to floor side rail.

FRONT END

Front end, which contains driver's compartment is composed of posts, panels, and castings. Front end includes front destination sign, windshield, front bumper, spare tire compartment, stepwell and retracting step.

REAR END

Rear end is composed of panels, posts, brackets, castings, rear window, and engine compartment doors. Engine is supported by rear end structure, which also contains electrical control compartment.

ROOF

Roof consists of posts, carlines, panels and drip mouldings. Roof is attached to side posts and window panels, and to front and rear end structures.

BAGGAGE COMPARTMENTS

Three transverse baggage compartments are located under seat floor between front and rear axles. Compartments are accessible through doors in both sides of vehicle. Cooling evaporator (if used) and heating radiator are located in front center of forward compartment. Air conditioning unit (if used) is located in left side intermediate compartment. Radio compartment is also located in intermediate compartment, accessible from front left-hand door.

PACKAGE RACKS

Interior package racks extend along each side of coach above windows. A narrow package rack connects side package racks above rear windows. Racks are supported by roof carlines and posts. Lower part of package racks contain air ducts for distribution of conditioned air to interior of coach.

INTERIOR PANELS

Masonite roof center trim panels are attached to carlines by moulding retainers, held with self-tapping screws. Snap-on mouldings attach directly to retainers. Lower masonite side panels are held at top and sides by mouldings attached with wire clips. Bottom of panels are held in channel of stainless steel kick panel. Kick panel is attached to side posts with self-tapping screws, and is held at bottom by channel in panel which fits over floor covering and floor rail.

EXTERIOR PANELS

Interior panels must be removed for access to exterior panel rivets. Refer to "Interior Panels" for panel removal instructions.

If riveting of exterior body panels is necessary remove moulding strips, then remove screws from upper panel moulding retainers. Seats must be removed before kick panels can be removed. Remove moulding clips carefully from lower panels.

Remove insulation carefully to avoid necessity of replacement due to damage.

To avoid stripping threads, do not over-tighten self-tapping screws. However, if threads are stripped, use existing holes and employ next larger size self-tapping screws.

When installing an exterior panel, seal all points of juncture with other parts with a suitable caulking compound, such as that listed under "Special Materials" at end of this section.

INSULATION

Body sides and roof are completely insulated by means of fibre glass and pads of cellular insulation between inner and outer panels. Engine compartment is coated with sound deadener compound to prevent entry of engine noise, heat, and fumes into body interior. Underside of floor in left side of intermediate baggage compartment is insulated to exclude heat and sound from air conditioning engine.

Side and rear windows are double-glazed to reduce heat transference and prevent fogging.

REPAIR AND REPLACEMENT

GENERAL

In the event of serious collision the Technical Service Department of GMC Truck and Coach Division will furnish dimensional data, sketches, and other information upon request.

Body and underframe can be repaired and replaced by competent craftsmen with proper tools and equipment.

Meanwhile preliminary work can be started, using dimensions given in figure 3 for checking purposes.

REPLACING BODY PARTS

Whenever repairing or replacing aluminum parts, carefully follow accepted and recommended practice. The Aluminum Company of America will furnish, upon request, booklets titled "Riveting Alcoa Aluminum" and "Welding and Brazing Alcoa Aluminum". The booklets explain detailed procedures necessary in the repair and replacement of aluminum parts.

Proper precautions must be observed, particularly with reference to welding, reinforcing, corrosion prevention, and replacement, as follows:

1. Welding of aluminum structural members, or any aluminum parts subject to strain or compression, is not recommended. To maintain proper body strength, replace damaged posts, carlines, and other structural members with new parts obtained from the factory.

2. To prevent galvanic corrosion of aluminum, all surfaces of dissimilar metals in contact with aluminum must be properly coated with paint and/or plating. This also applies to attaching parts such as bolts, washers, nuts, and rivets. Refer to "Repainting Aluminum Parts" and "Painting New Aluminum Parts" later in this section.

CAUTION: Avoid mixing steel and aluminum structures or parts when making repairs. Do not substitute steel for aluminum in understructure, rub rails, etc., although steel can be used for support fittings for separate units, such as air tanks, control rods, etc. Greater deflection (lower modulus) of aluminum causes steel members to tend to take entire load when used in combination with aluminum parts.

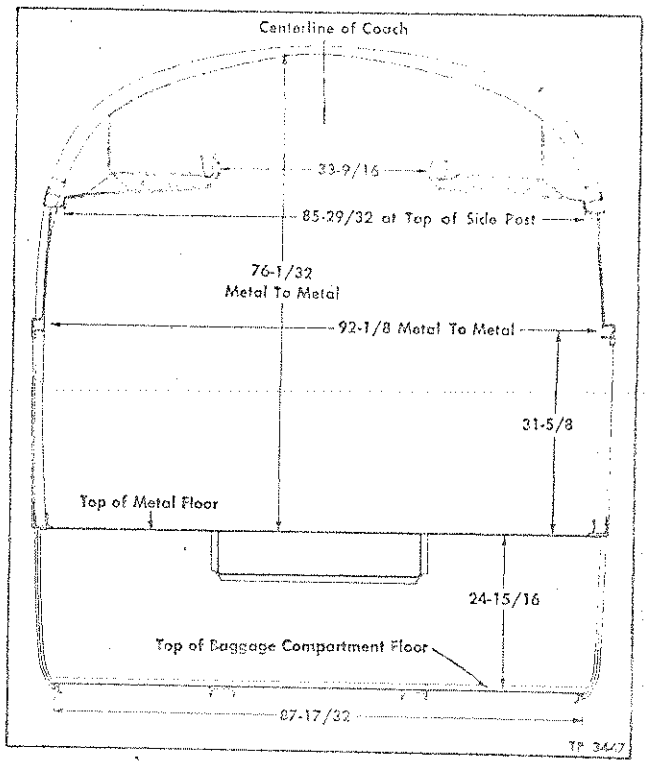


Figure 3—Dimensioned Cross Section of Body

STRAIGHTENING

Use of heat when straightening structural parts of body is not recommended, since heat affects structural characteristics of certain alloys and especially heat-treated parts. Body structural members should be straightened cold; any part bent or buckled sufficiently to show strains or cracks after straightening should be replaced, or properly welded and reinforced.

CUTTING

When cutting a structural member, cut at an angle of 30 degrees. Thus, actual length of cut is twice width of piece being cut, and stress or

load is distributed over a longer joint when welded. Cutting can be done by torch, although use of saw is preferred, since cut is cleaner and less material is removed.

REINFORCING

CAUTION: Before reinforcing any part of vehicle, determine cause of failure. Body and frame are integral; therefore, driving stresses and strains are transmitted throughout body. Reinforcing a point of apparent failure without correcting underlying cause of failure, may transfer stress to other parts not engineered for such stress, with resultant development of new failures. Since body is designed to "weave", a rigid reinforcement in any part of body may nullify the design of entire vehicle.

Reinforcements can be made of flat, angle or channel stock, whichever is most suitable for purpose. Use of angle reinforcements is recommended due to difficulty in fitting channel reinforcements. Reinforcements should be sufficiently long to distribute load evenly over a considerable area and thickness should not exceed that of member being reinforced. Reinforcements should be riveted to broken part.

RIVETING

Cold aluminum rivets should be used in aluminum parts.

Diameter of rivets should be approximately 100% thickness of plates to be riveted although rivet diameter is also dependent upon spacing and number used.

Replacement of body parts will necessitate removal of rivets in many cases. Rivets can be removed most easily by cutting off rivet head with a sharp chisel, marking center of rivet with a center punch, then drilling out rivet with a drill slightly smaller than body of rivet. Rivet can also be driven out with punch, instead of being drilled out, depending upon type and size of material riveted. If rivet is large, first cut out a groove across center of rivet head with a cape chisel before cutting off head with a flat chisel.

WELDING

Refer to note, earlier in this section, regarding welding of structural parts.

Shielded arc welding is recommended as heat of weld is localized and burning of material minimized with this method. When welding a cut member, fill or weld cut completely. Welding rods should be of substantially same material as parts to be welded.

SEALING

When replacing front, side, rear panels, and particularly roof panels, special attention should be given to proper sealing of joints. Use of the sealing and caulking compound, listed at the end of this section, is recommended wherever necessary to exclude water, dust, cold, and air.

DINGING AND FINISHING

Paint is quickly scuffed off sharp dents leaving bare metal exposed to corrosion. Importance of proper metal finishing to produce a fairly smooth surface should, therefore, not be underestimated. Application of hammer directly to panel tends to stretch the metal unnecessarily. Whenever possible a spoon should be used when bumping a panel. Repair damaged panels by forcing outward in direction opposite to force which caused damage. In this way metal strains set up when damage occurred, are relieved.

PAINTING

Aluminum corrodes just as iron and steel rusts; under certain conditions aluminum will corrode more rapidly than steel. Vehicles should therefore be inspected regularly for corrosion damage and for condition of paint coatings, in order that corrective measures may be applied as necessary.

REPAINTING ALUMINUM PARTS

1. Thorough cleaning is essential. All corrosion products, grease and other foreign matter must be removed. Solvent cleaning, pressure steam cleaning, wire brushing, and hand sanding methods are recommended.

2. Completely remove old paint by use of organic solvents - do not use alkaline paint remover on aluminum. If old primer is very difficult to remove and there is no evidence of metal corrosion, old primer may be left on, but all loose paint must be removed.

3. Apply warm 5% sodium dichromate or potassium dichromate solution (two ounces dichromate in one quart of water) to cleaned surfaces. Apply by spraying. Allow parts to dry.

4. Use a zinc chromate primer such as DuPont 63-1016 or Arco 214-30089 or any equivalent material made by a reputable manufacturer.

Apply primer, preferably by spraying in a very thin coat. Properly applied primer will be greenish in color; yellow color indicates too heavy a coating. If zinc chromate primer cannot be obtained, use of a red oxide primer is recommended, but only as an emergency measure.

5. Apply finish coats:

a. For understructure and other parts not requiring color, apply two coats of the following, or equivalent: Reduce 5 parts of DuPont RC-147 clear Dulux with 1 part Duco #3637 Thinner.

To each gallon add 2 pounds Albron (aluminum) paste, stirring mixture thoroughly.

If synthetic aluminum enamel is not available, any synthetic or other enamel, aluminum lacquer, or other lacquer, in that order, may be used; but only materials made by a reputable manufacturer should be employed. Then apply one heavy coat of asphalt-base sheet-metal deadener approximately 1/32 inch thick. Special spray equipment, including pressure tank, must be used if deadener is applied by spraying.

b. To exposed body parts, apply air-drying surfacer and color coats in accordance with standard practice.

REPAINTING STEEL PARTS

The foregoing procedures may also be applied to steel and iron parts, with following exceptions:

1. Use of phosphoric-base metal conditioner, such as "Metalprep" (Neilson Chemical Co.) or "Deoxidine" (American Chemical Paint Co.) or equivalent, is recommended in preparing steel for painting. These materials vary in method of application and use, and should be employed only as directed by the manufacturer.

2. Both organic and alkaline paint removers may be used on steel parts. However, if alkaline removers are used, all traces of alkali must be washed off before primer is applied.

3. Oxide-type primer is recommended for use on steel parts, instead of zinc chromate primer. Zinc chromate primer should not be used on steel unless parts have been slightly roughened by sanding.

PAINTING NEW ALUMINUM PARTS

When installing new aluminum parts, or new parts which contact with aluminum parts in assembly, succeeding procedures should be followed:

1. Remove from vehicle old parts to be replaced.

2. Treat all exposed sides of adjacent parts remaining in body according to instructions in paragraphs 1, 2, 3, and 4 under "Repainting Aluminum Parts" if aluminum; if steel treat as in paragraphs 1, 2, and 3 under "Repainting Steel Parts."

3. Prime coat all sides of new parts to be installed as outlined in paragraph 4 of "Repainting Aluminum Parts," and paragraph 3 of "Repainting Steel Parts." Use only zinc or cadmium coated bolts, washers, and nuts. Dip all bolts, nuts, washers, and rivets in primer and allow to dry.

4. Install new parts, then apply finish coats as outlined in paragraph 5 of "Repainting Aluminum Parts."

PAINTING NEW STEEL PARTS

The above procedures may be applied to new steel and iron parts except that oxide base primers are recommended in place of zinc chromate type.

NEW VEHICLES

CAUTION: Vehicles delivered in surfacer, with color coats omitted, should be painted immediately upon receipt of vehicle. Primer and surfacer coats afford little protection against corrosion. Main purpose of primer is to bond succeeding coats to metal while surfacer coat is used only to smooth out any roughness in surface. Both primer and surfacer coats are porous in nature; severe chalking will occur rapidly, with possible flaking during freezing weather, unless vehicle is promptly painted.

Due to deterioration of surfacer, accumulation of road film, etc., while in transit, satisfactory coating and prevention of corrosion can be achieved only by proper preparation.

1. Wash vehicle thoroughly with clear water, using no soaps or chemical cleaners.

2. Thoroughly sandpaper surfacer, using dry paper of light weight grit, preferably 350-400 grade. If vehicle has been in service, it will be necessary to remove virtually all of the original surfacer by sanding.

3. Apply a coating of a good grade of surfacer and allow to dry thoroughly (at least 8 hours, preferably longer). Sand surfacer, using sandpaper of 350-400 grit.

4. Apply color coats in accordance with standard practice.

DOORS AND CONTROLS

Vehicle has two passenger doors - front entrance and emergency. Both doors are sedan type, hinged at front, and open outwardly.

ENTRANCE DOOR MECHANISM

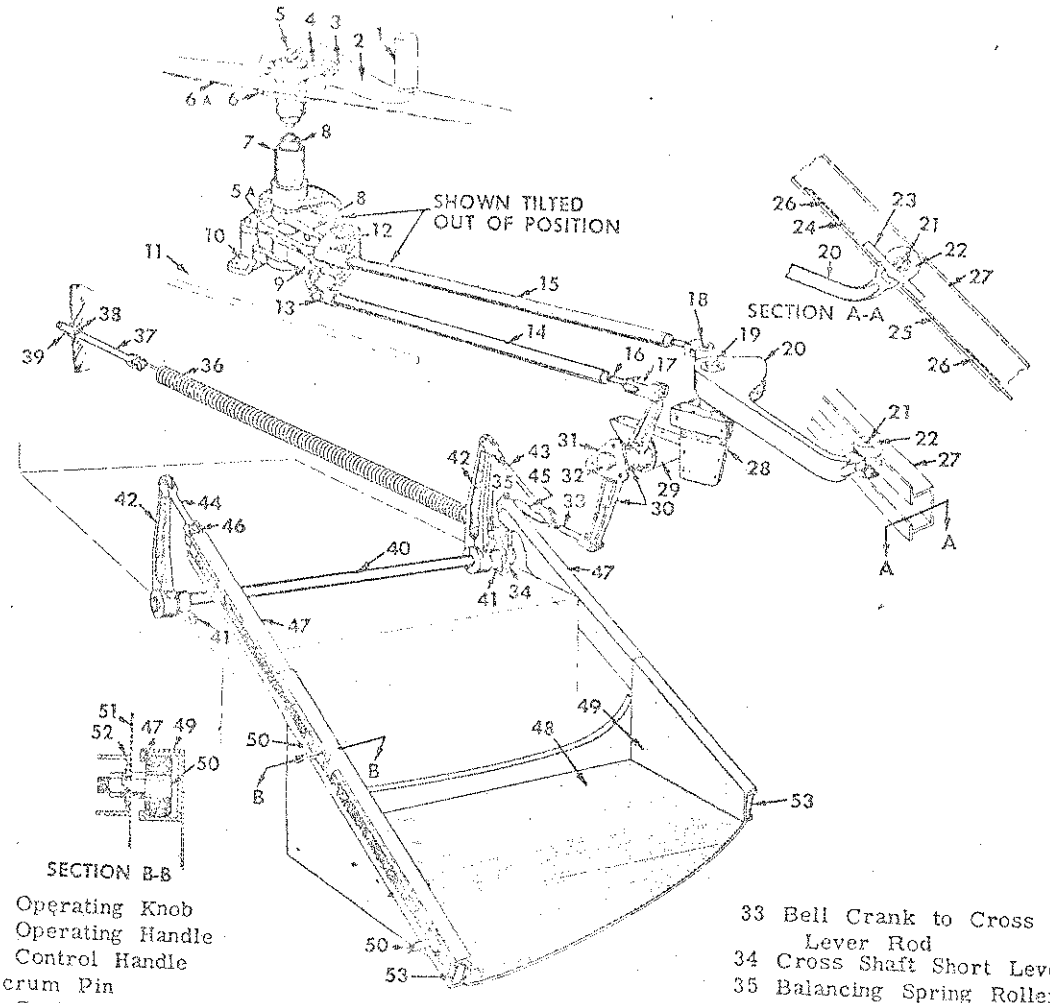
Entrance door is hand-operated type controlled by handle on windshield ledge. Door operating mechanism is illustrated in figure 4. Mechanism is so designed that door is locked firmly in either fully open, or fully closed positions. Door, however, can be opened from outside by pressing door lock release button, located on outside of front panel below front emblem light. Pressing release button forces lock past center, releasing door.

Door can be operated either independently or in conjunction with retracting step.

OPERATION

(Key Numbers Refer to Figure 4)

Door is opened and closed by rotating knob (1). Motion of handle (2) turns door control tube



1 Door Operating Knob
2 Door Operating Handle
3 Door Control Handle Fulcrum Pin
4 Door Control Handle Level
5 Retracting Step Lift Rod
5A Door and Step Control Interlock
6 Door Control Shaft Bracket
6A Windshield Ledge
7 Control Rod Housing Tube
8 Door Control Tube and Lever
9 Step Control Lever
10 Door and Step Control Bracket
11 Front Compartment Floor Sheet
12 Door Operating Rod Yoke
13 Step Operating Rod Yoke
14 Step Operating Rod
15 Door Operating Rod
16 Step Control Tube Screw Eye
17 Step Control Yoke
18 Door Operating Lever Yoke
19 Door Operating Lever Shaft
20 Door Operating Lever
21 Door Operating Lever Roller Pin
22 Door Operating Lever Roller
23 Door Operating Lever Seal Shoe
24 Door Operating Lever Front Seal
25 Door Operating Lever Rear Seal
26 Door Operating Lever Seal Guide
27 Door Roller Track
28 Door Operating Lever
29 Bell Crank Front Bracket
30 Step Control Bell Crank
31 Bell Crank Shaft Rear Bracket
32 Bell Crank Through Bolt
33 Bell Crank to Cross Shaft Lever Rod
34 Cross Shaft Short Lever
35 Balancing Spring Roller
36 Retracting Step Balancing Spring
37 Retracting Spring Eye Bolt
38 Spring Eye Bolt Adjusting Nut
39 Spring Eye Bolt Lock Nut
40 Step Operating Cross Shaft
41 Cross Shaft Bearing
42 Operating Lever
43 Front Operating Lever Rod
44 Rear Operating Lever Rod
45 Front Track Operating Bracket
46 Rear Track Operating Bracket
47 Step Roller Track
48 Step Bottom Plate
49 Step Side Plate
50 Step Roller and Bearing
51 Front Underframe Bulkhead
52 Roller Reinforcement
53 Roller Track Stop

TP 3423

Figure 4—Entrance Door and Retracting Step Mechanism

and lever (8), transmitting movement through yoke (17) to operating rod (15). Operating rod actuates door operating lever (20), moving roller (22) in track (27) to open or close door.

Retracting step is operated in conjunction with door by pressing downward on knob (1) while rotating handle (2). Downward pressure on knob (1) causes handle (2) to fulcrum on pin (3) raising retracting step lift rod (5). Lift rod moves door and step interlock (5A) engaging pins in holes in door control tube and lever (8). Step control lever (9) and door control tube and lever (8) are now locked together by means of interlock (5A).

With door and step mechanisms interlocked, door operates as previously described. In addition, rotation of handle (2) operates step control lever (9) moving step operating rod (14) and rotating step control bell crank (30). Movement of bell crank is transmitted through lever rod (33) and short lever (34) to operating cross shaft (40). Cross shaft (40), in turn, moves step on rollers (50) through long levers (42) and operating lever rods (43 and 44). Weight of retracting step is balanced by spring (36).

MAINTENANCE

Door and step mechanism requires no maintenance other than occasional sparing lubrication. All major points of friction, including step rollers, incorporate sealed - type roller bearings. Other points, however, should be lubricated.

ADJUSTMENT (Key Numbers Refer to Fig. 4)

Door operating rod (15) is adjusted by disconnecting operating lever yoke (18), loosening lock nut, then turning yoke (18) to lengthen or shorten rod. Yoke is accessible through safety equipment compartment door in dash panel. Whenever adjustment is made, be sure that mechanism locks over center in both fully opened and fully closed positions of door. In either position, it should not be possible to move door unless handle is first moved out of locking position.

Step operating rod (14) is provided with means of adjustment to obtain synchronous operation of door and step. Adjust by disconnecting screw eye (16) from yoke (17), loosening lock nut, and turning yoke (17) as necessary to shorten or lengthen operating rod. Yoke and screw eye are accessible through safety equipment compartment door in dash panel. Adjust so that step is fully extended with door fully open; operating bracket (46) must "bottom on roller (50).

Front operating rod (43) is adjustable for alignment of step tracks with rollers. If step moves or "cocks" when weight is applied to step, rod (43) should be adjusted. Rod (43) is accessible from underneath coach with step in fully extended position.

Tension of balancing spring (36) is varied by nuts (38 and 39) which are accessible through opening after removal of left-hand fog light.

RETRACTING STEP REMOVAL

Retracting step can easily be removed, if damage to step prevents closing door (fig. 4).

With step extended, remove bolts and nuts which attach front track operating bracket (45) to front roller track (47). Bracket bolts are accessible from underneath coach.

Open triangular cover plate in rear side of stepwell. Through opening, remove two bolts and nuts which attach rear track operating bracket (46) to rear roller track (47). Step is removed by pulling downward and outward.

ENTRANCE DOOR

Entrance door (fig. 5) is composed of aluminum panels and framing. Door requires no maintenance other than regular lubrication of hinges and periodic inspection of seals.

Mirror brackets are attached to door. Brackets are so designed that pressure on outer edge of mirror causes mirror to swing parallel to door, thus permitting use of automatic washing equipment.

Step light, shown in figure 5, is covered in Lighting System (Sec. 7G of this manual).

Entrance door window is opened and closed by hand-operated regulator. Regulator is double-arm type, designed to hold window securely in any desired position. Replacement of window glass is covered under "Glass Replacement" later in this section.

EMERGENCY DOOR

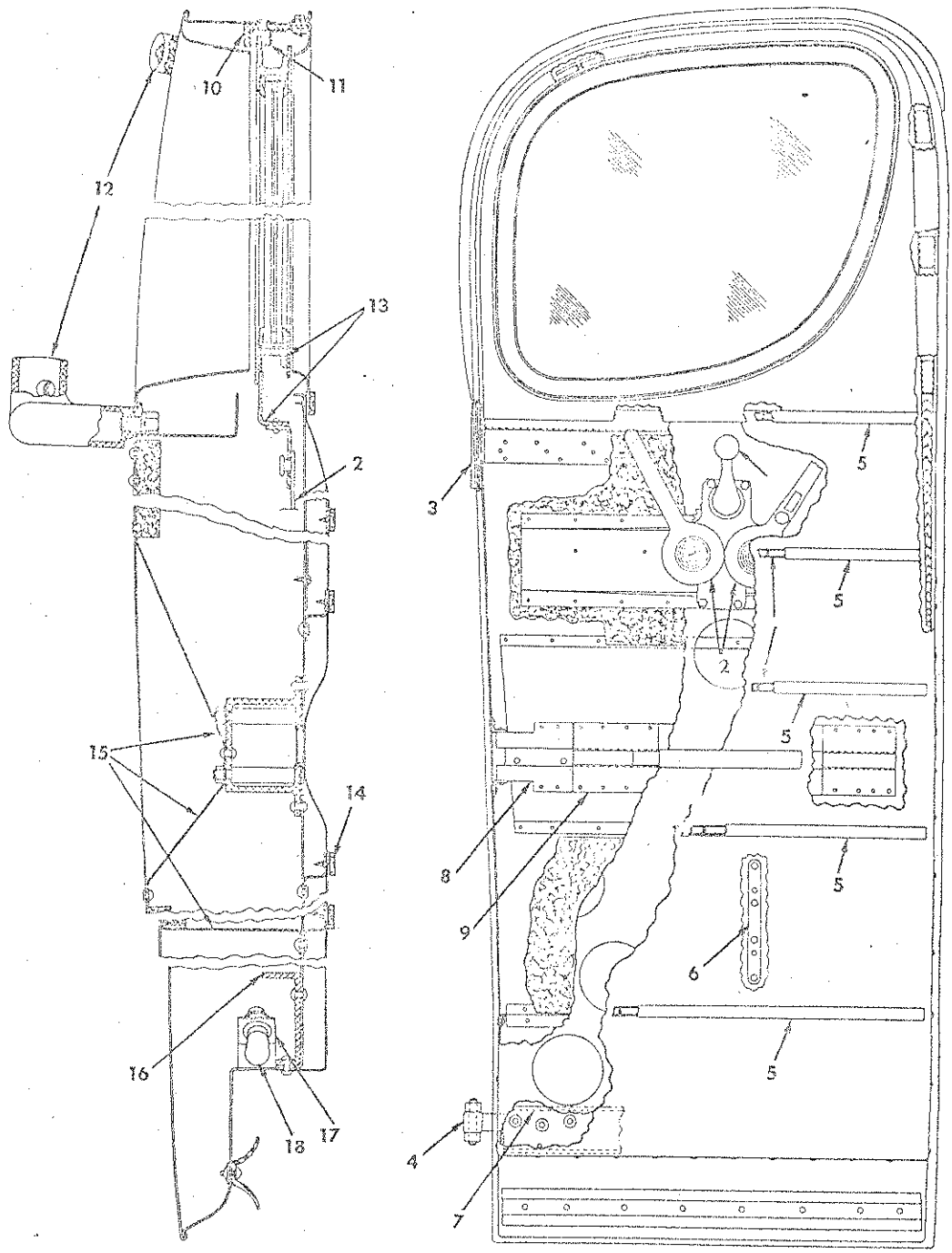
Emergency door is located on left-hand side of coach, immediately back of rear wheel. Door, which is hinged at front and opens outward, is equipped with a manually-operated locking lever mechanism.

Door requires no maintenance other than periodic inspection of seals, and occasional sparing lubrication of hinge and locking mechanism. Emergency door should be tested daily to make sure of proper operation of door, lock, and warning signals.

EMERGENCY DOOR SWITCH

Emergency door switch is mounted on door lever catch, movement of which closes switch contacts. Whenever door is not closed or atched, switch completes circuit to emergency door telltale and alarm buzzer.

Refer to Wiring and Miscellaneous Electrical (Sec. 7A of this manual) for maintenance and repair information, and to wiring diagrams in that section for switch electrical circuits.



1 Window Regulator Handle
2 Window Regulator
3 Upper Hinge
4 Lower Hinge
5 Moulding
6 Reflector Spacer (Outside of Door)
7 Channel
8 Door Roller Track
9 Guide
10 Window Frame
11 Window Channel
12 Mirror Brackets
13 Sash
14 Moulding Retainer
15 Reinforcement Panels
16 Channel
17 Bracket
18 Step Light Bulb

Figure 5—Front Entrance Door Construction

BODY

SASH AND GLASS

RUBBER INSERT RETAINED GLASS

A special insert-type rubber retainer is used to install glass in front destination sign, windshield, rear windows, and target sign. It should be noted that rear window glass is a double-glazed sealed unit; however, removal and installation instructions are also applicable to this unit.

Although possible to install retainer and seal insert without use of special tools, tools listed in "Special Tools" at end of this section, are recommended to facilitate installation (fig. 6).

GLASS REMOVAL

1. With pointed tool raise one end of insert out of groove in retainer seal, then pull insert from seal by hand.
2. Push glass outward from inside vehicle; an assistant outside should prevent glass falling.
3. Remove rubber retainer seal from panel by hand.

GLASS INSTALLATION

1. Straighten panel flange around opening to assure a good fit in retainer seal groove.
2. Cut new glass to provide following clearance between glass and panel opening on all sides:

Location	Clearance
Front Destination Sign	9/32"
Windshield	19/64"
Target Sign	9/32"

3. Position retainer seal in panel cut-out, making sure seal is pushed into place in corners. Ends of seal should come together at side of opening near top.
4. Cut off retainer seal ends, allowing sufficient overlap to secure a tight joint and carefully butt into position.
5. Apply soap solution to glass groove in retainer seal to facilitate glass installation.
6. Position glass to seal, insert end of retainer seal installer (fig. 6) in seal groove and move tool along edge of glass forcing outer lip of seal over glass. Use large installer (hook) (part of CS-1154-A) for all except rear window. For rear window use special installer (hook) CS-1154-12.
7. Thread end of rubber insert through seal insert installer (fig. 5). At point opposite joint in retainer seal, push tool loop and end of insert into seal groove. Feed into groove in retainer seal. Use a hitching motion to prevent elongation of insert. Use large installer (7/16" eye, part of CS-1154-A) for all installations.
8. Cut off insert, allowing overlap, and butt ends tightly into groove.

SIDE WINDOW SASH

All side window sash is equipped with sealed double-glazed windows. A drying agent is incorporated between the two panes to absorb moisture, preventing fogging and steaming between the outer and inner panes. Design is such that breakage of either pane will necessitate replacement with a complete sealed glass assembly.

Emergency Escape

Side window sash is hinged to body at bottom of sash to provide passenger escape under emergency conditions. Sash is held in closed position by spring-loaded latches at top. A strong push against top of window overcomes latch springs and causes window to swing outward and downward against body side. CAUTION: Window should be opened in this manner only during an emergency, since damage to body side, sash frame, or glass usually results.

Cleaning

Both interior and exterior surfaces of windows may be cleaned from outside of coach. Metal eye on top outer part of sash frame can be engaged with a hook. Pulling sharply on hook opens window, providing access to inside of glass.

Tension of latches can easily be adjusted from outside vehicle. Use screwdriver to reach adjusting screws under roof side drip moulding.

Ventilation

Side windows can be opened for ventilation in event of failure of air-cooling unit. Each window regulator must be individually unlocked with

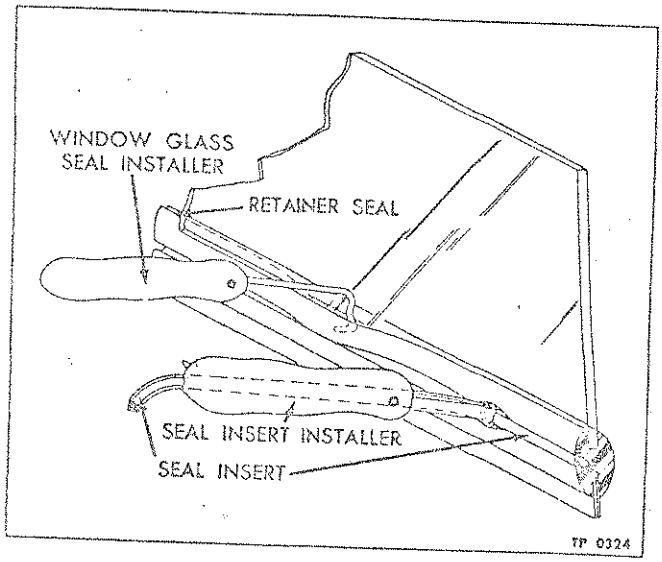


Figure 6—Installing Glass Retainer Seal and Insert

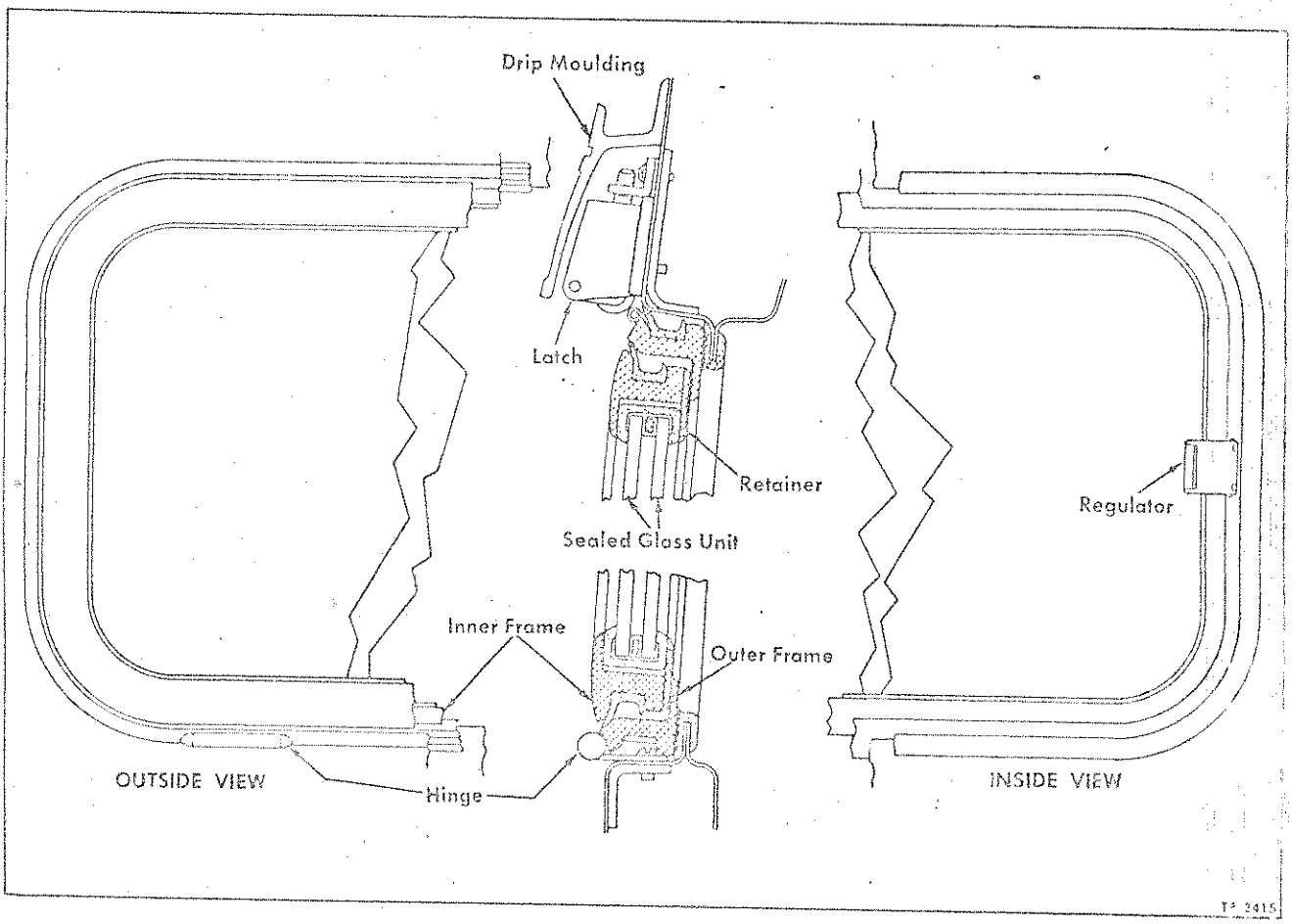


Figure 7—Side Window Sash

driver's key. Rear of window can then be opened outward approximately 1-1/2 inches, this being limited by regulator. When window is closed, spring lock in regulator automatically engages. Window cannot be opened unless again unlocked with driver's key.

GLASS REMOVAL

1. Engage hook in eye at outer top of sash. Open window by pulling sharply on hook.
2. Unlock regulator with driver's key. Open window regulator to remove regulator tension.
3. Support inner frame and remove two screws which attach regulator to outer frame. Remove four screws which attach inner frame hinges to outer frame.
4. Position inner frame on bench for disassembly. Remove screws which attach glass retainer to frame.
5. Remove glass retainer from frame, then remove glass.

GLASS INSTALLATION

1. Clean glass channel thoroughly then position glass in frame.
2. Position glass retainer in frame and install attaching screws. Tighten screws evenly and firmly.
3. Position inner frame in outer frame and install four hinge screws.
4. Position regulator to outer frame and install two attaching screws.
5. Swing window upward into closed position. Make sure that latches have correct tension and adjust, if necessary.

SASH REMOVAL

Entire sash is readily removed after opening window to emergency escape position. Pry small spring-loaded pin from hinge pin with screwdriver. Hold small pin while sliding sash to side. Sash is free when hinge pins are disengaged.

ENTRANCE DOOR WINDOW

Window is raised and lowered by a manually-operated regulator. Double-arm regulator is designed to hold window in any desired position. Window is double-glazed, and incorporates a dry-

ing agent between the panes to absorb moisture and prevent fogging. Glass is supplied as a sealed assembly, complete with rubber channel. In the event of breakage of one pane, a new sealed assembly must be installed.

DOOR WINDOW GLASS REMOVAL

1. Crank door window down. Remove upper snap-on garnish moulding, then remove moulding retainer.

2. Remove screws from lower edge of upper inside panel. Remove screws, bolts, and nuts which attach upper inside panel to door header, and remove panel.

3. Crank door window completely up. Remove screws from glass retainer then remove retainer. Remove glass from sash frame.

DOOR WINDOW GLASS INSTALLATION

1. Make sure frame channel is clean then position glass in channel.

2. Position glass retainer in sash frame and install attaching screws.

3. Position upper inside panel in door and install attaching screws, bolts, and nuts.

4. Attach garnish moulding retainer then install snap-on garnish moulding.

DOOR WINDOW SASH REMOVAL

1. Remove upper garnish mouldings and moulding retainers. Crank window down.

2. Remove screws, bolts, and nuts which attach upper inside panel, then remove panel. Remove upper trim panel from door.

3. Remove 11 screws from sash channel retainer, then remove retainer. Remove exposed screws from sash channel then crank window up.

4. Remove screws from lower ends of sash channel. Tilt top of sash with sash channel inward, to clear door header.

5. Crank regulator up as far as possible. Disengage regulator cams from sash, then remove sash with channel from door.

DOOR WINDOW SASH INSTALLATION

1. Position sash channel on sash. Slide channel and sash down into door.

2. Engage regulator cams in horizontal slots in sash. Crank regulator down far enough to position sash channel in door.

3. Install screws in sash channel. Position sash channel retainer and install attaching screws.

4. Make sure of free operation of sash before proceeding. Install upper trim panel.

5. Position upper inside panel and install attaching screws, bolts, and nuts.

6. Attach garnish moulding retainers then install mouldings.

DRIVER'S WINDOW

Window is raised and lowered by manually-operated regulator. Double-arm regulator is designed to hold window in any desired position. Window is double-glazed, and incorporates a drying agent between the panes to absorb moisture and prevent fogging. Glass is supplied as a sealed assembly, complete with rubber channel. In the event of breakage of either pane, complete sealed assembly must be installed.

DRIVER'S WINDOW SASH REMOVAL

1. Remove horizontal snap-on moulding below window, then remove moulding retainer.

2. Crank window down. Remove screws from lower edge, sides, and top of window garnish moulding, then remove moulding.

3. If only glass is to be removed, take out glass retainer screws, remove retainer, then remove glass from sash frame. Otherwise, proceed as follows:

4. Remove sash channel screws, then pull top of channel inward. Crank window up while pulling top of window inward.

5. When regulator reaches maximum upward travel position, disengage regulator cams from slots in sash. Pull sash with channel from window opening.

DRIVER'S WINDOW SASH INSTALLATION

1. Position sash channel on sash, then slide both down far enough to engage regulator cams in slots in sash.

2. Crank window down, position channel in opening and install channel screws.

3. Position window garnish moulding to window opening, then install attaching screws.

4. Install snap-on moulding retainer, then install moulding.

MISCELLANEOUS EQUIPMENT

WINDSHIELD WIPERS

Two air-operated windshield wipers are mounted in front panels, below windshield. Air pressure for wiper operation is supplied by the auxiliary air system, fed, in turn, from the vehicle air system. A pressure regulating valve, interposed in air lines, prevents depletion of main air system by shutting off air to auxiliary air system when pressure in main system falls below approximately 65 pounds. Wiper speed is controlled by dual or single (spec. eqpt.) control valves mounted

BODY

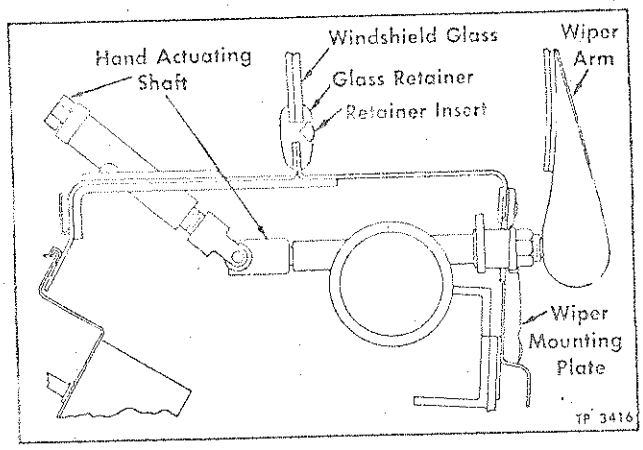


Figure 8—Windshield Wiper Mounting

on instrument board at left of gauge panel.

Refer to Air Brakes (Sec. 4B of this manual) for air line diagrams and information on air lines and connections, including maintenance and repair information on pressure regulating valve.

CONTROL VALVE

Windshield wiper control valve is fitted with an adjustable "stop-knob" to prevent operation of wiper at excessive speeds, with resultant rapid wear of motor. To adjust, loosen two set screws and pull knob off valve. Adjust regulator screw to provide proper motor speed, making due allowance for slower speed if adjustment is made with windshield dry. When correct adjustment is obtained, position stop knob on regulator screw, being careful that adjustment is not disturbed. Tighten knob set screws firmly, while pressing knob against valve body. If adjustment is properly made, knob will "bottom" on valve body, when wiper motors operate at maximum desired speed.

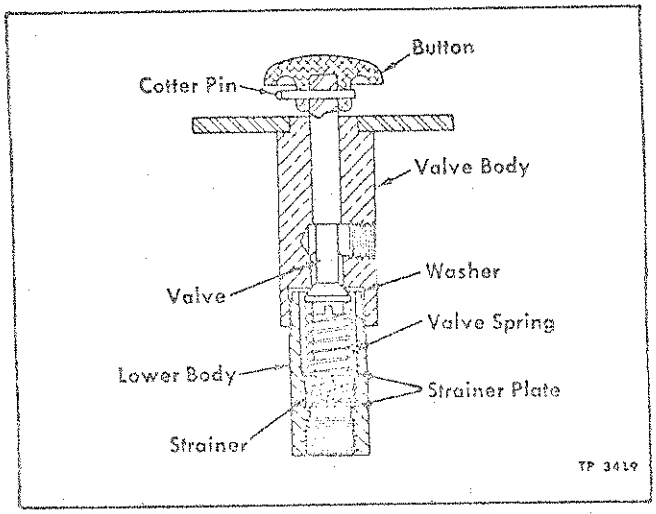


Figure 9—Air Horn Foot Valve

HAND ACTUATING MECHANISM

Hand mechanism (fig. 8) permits driver to keep left-hand windshield clear in the event of wiper motor failure. Mechanism requires no maintenance other than occasional sparing lubrication.

MAINTENANCE

Windshield wiper motors are designed to require no special maintenance and should remain undisturbed unless motors fail to function. Before replacing motors, check all tubing, connections and control valves for leaks or plugging.

REPLACEMENT

Windshield wiper motors are easily replaced being attached to mounting plates removable from outside coach (fig. 8). Mounting plate is attached to front panel with eight oval head screws. Motor is attached to mounting plate with two hex head cap screws and lockwashers.

When installing motor make sure mounting plate gasket is in good condition. Coat both sides of gasket with a thin layer of a suitable sealing and caulking compound, such as that listed at end of this section.

AIR HORNS

Dual air horns are mounted on bracket located in horn compartment. Horns are accessible from underneath left front corner of coach. Air pressure to horns is controlled by driver's foot control valve. Air pressure is supplied by auxiliary air system, obtained in turn, from main air system. Pressure regulating valve in air lines prevents depletion of main air system by shutting off air to auxiliary air system when pressure in main system falls below approximately 65 pounds.

Refer to Air Brakes (Sec. 4B of this manual) for air line diagrams and information on air lines and connections. Pressure regulating valve maintenance and repair information is also contained in that section.

REPAIR

Sound is produced by stainless steel reed vibrating between two seats. Seats are separated 1/32", this spacing being maintained by a gasket.

Horn is non-adjustable, and requires no maintenance.

In the event of horn failure, make sure that air system pressure is at least 75 lbs. Sticking reed may be cause of failure; usually reed can be freed without removing horn from vehicle. Tap reed through back opening of horn while assistant operates driver's foot control valve intermittently. If this fails to free reed, removal and disassembly of horn is necessary. Seats can be

cleaned with a flat oil stone. Since reeds act as air valves, reeds must be flat. If not flat, replace reeds.

FOOT CONTROL VALVE

Valve, which controls operation of air horns, is mounted in driver's floor, with valve body extending downward into tool compartment (fig. 9). Valve requires no maintenance, but can be easily checked for leakage with soap and water solution.

If leakage does occur, valve should be disassembled and lapped, using fine valve grinding compound. After grinding, wash all parts in gasoline and blow with compressed air to remove all traces of grinding compound.

Whenever valve is disassembled, or in event of weak horn action, curled hair strainer in lower body should be cleaned. Lower body is threaded into valve body, and is removed by unscrewing.

PASSENGER BUZZER AND SWITCHES

Passenger buzzer (fig. 10) is mounted on left side of buzzer and relay panel, located back of driver's switch panel. Buzzer is sounded by switches mounted under package racks near front. Switches are operated by pull cords at top of side windows. Buzzer circuit, fed through "Run" position of engine control switch, is protected by No. 4 fuse in instrument panel. Buzzer electrical circuit is shown in wiring diagram in Wiring and Miscellaneous Electrical (Sec. 7A of this manual).

MAINTENANCE

Buzzer and relay panel, on which passenger buzzer is mounted, is accessible by removing instrument board switch panel. No regular maintenance of buzzer is recommended due to difficulty of access. Consequently, whenever switch panel is removed, buzzer cover should be removed, points inspected and, if necessary, cleaned with fine crocus cloth. Contact points should also be adjusted, if necessary (fig. 10).

Buzzer switches require no maintenance; however snap-on cover is easily removable for inspection and cleaning of contacts.

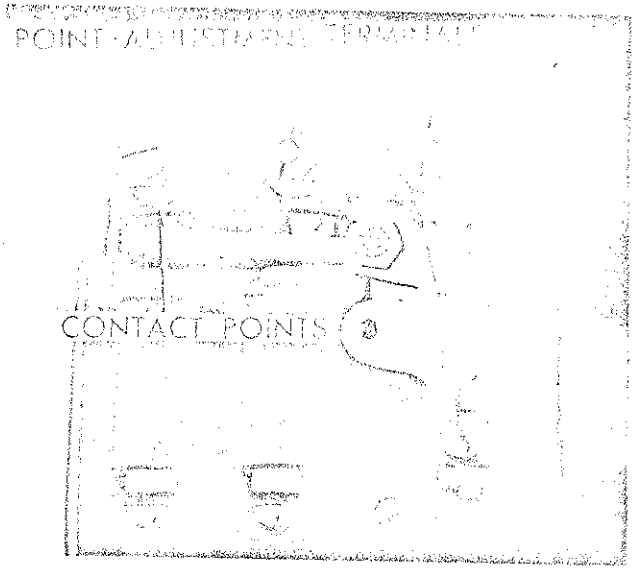


Figure 10—Passenger Buzzer

TEST

If buzzer fails to operate with either switch, first make sure that No. 4 instrument panel fuse is not blown. Check circuits as follows, using voltmeter or test light having a 12 volt 1.5 candlepower bulb:

1. Turn engine control switch to "Run" position. Ground one test lead and touch other to both ends of No. 4 fuse. If no current indication is obtained at either point, check for open circuit in feed to fuse. If current is obtained at only one point, fuse or fuse clips are defective.

2. With a jumper wire, ground No. 22 junction on instrument panel junction panel. If buzzer sounds trouble is probably in switches or in wiring to switches. If buzzer does not sound; trouble is probably in buzzer.

3. Remove buzzer cover and make sure points are clean and in contact. Ground one test lead and touch other to buzzer terminals while holding points open. Current should be obtained at one terminal. Ground other (dead) terminal with a jumper wire.

4. If buzzer sounds, check circuit continuity from buzzer through switches to ground. If buzzer does not sound, remove buzzer for repair or replacement.

HEATING AND VENTILATION

Coaches are equipped at the factory with a standard heating and ventilating system. Provision is made for later installation of cooling (air conditioning) equipment. Since coach manufacturer does not install cooling unit, no attempt is made to cover cooling equipment as a system, in this manual. Some components of the heating ventilating system are common to both heating and cooling systems. Consequently certain units of the cooling system (blowers, ducts, electrical, etc.) are covered herein, but only as these items relate to the heating and ventilating systems.

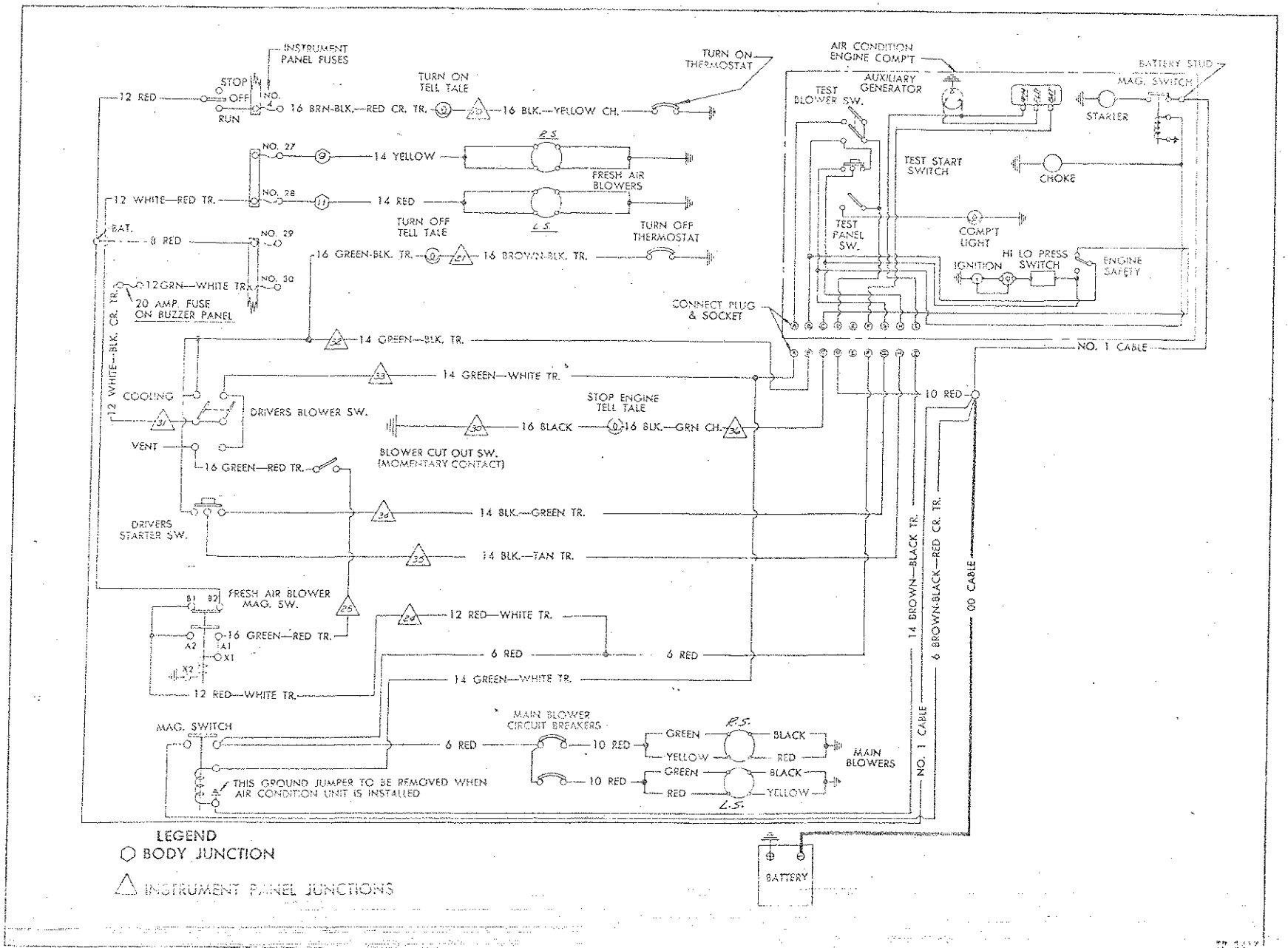

INSTRUMENT PANEL FUSES
STOP
OFF
RUN
NO.
12 RED
16 BRN-BLK.—RED CR. TR.
TURN ON TELL TALE
16 BLK.—YELLOW CH.
TURN ON THERMOSTAT
AIR CONDITION ENGINE COMP'T
AUXILIARY GENERATOR
TEST BLOWER SW.
BATTERY STUD
MAG. SWITCH
STARTER
NO. 27
14 YELLOW
R.S.
FRESH AIR BLOWERS
NO. 28
12 WHITE—RED TR.
14 RED
L.S.
TEST START SWITCH
CHOKE
BAT.
8 RED
NO. 29
TURN OFF TELL TALE
16 GREEN-BLK. TR.
16 BROWN-BLK. TR.
TURN OFF THERMOSTAT
TEST PANEL SW.
COMP'T LIGHT
HI LO PRESS SWITCH
IGNITION
ENGINE SAFETY
NO. 30
12 GRN—WHITE TR.
20 AMP. FUSE ON BUZZER PANEL
CONNECT PLUG & SOCKET
12 WHITE—BLK. CR. TR.
14 GREEN—BLK. TR.
NO. 1 CABLE
14 GREEN—WHITE TR.
COOLING
DRIVERS BLOWER SW.
STOP ENGINE TELL TALE
10 RED
16 BLACK
16 BLK.—GRN CH.
VENT
BLOWER CUT OUT SW. (MOMENTARY CONTACT)
16 GREEN—RED TR.
DRIVERS STARTER SW.
14 BLK.—GREEN TR.
14 BLK.—TAN TR.
FRESH AIR BLOWER MAG. SW.
B1
B2
A2
A1
X1
X2
16 GREEN—RED TR.
12 RED—WHITE TR.
6 RED
6 RED
14 GREEN—WHITE TR.
12 RED—WHITE TR.
14 BROWN—BLACK TR.
6 BROWN-BLACK—RED CR. TR.
00 CABLE
NO. 1 CABLE
MAG. SWITCH
MAIN BLOWER CIRCUIT BREAKERS
6 RED
10 RED
10 RED
GREEN
YELLOW
BLACK
RED
GREEN
RED
BLACK
YELLOW
R.S.
L.S.
MAIN BLOWERS
THIS GROUND JUMPER TO BE REMOVED WHEN AIR CONDITION UNIT IS INSTALLED
BATTERY
LEGEND
BODY JUNCTION
INSTRUMENT PANEL JUNCTIONS

Figure 11—Heating and Ventilating Wiring Diagram

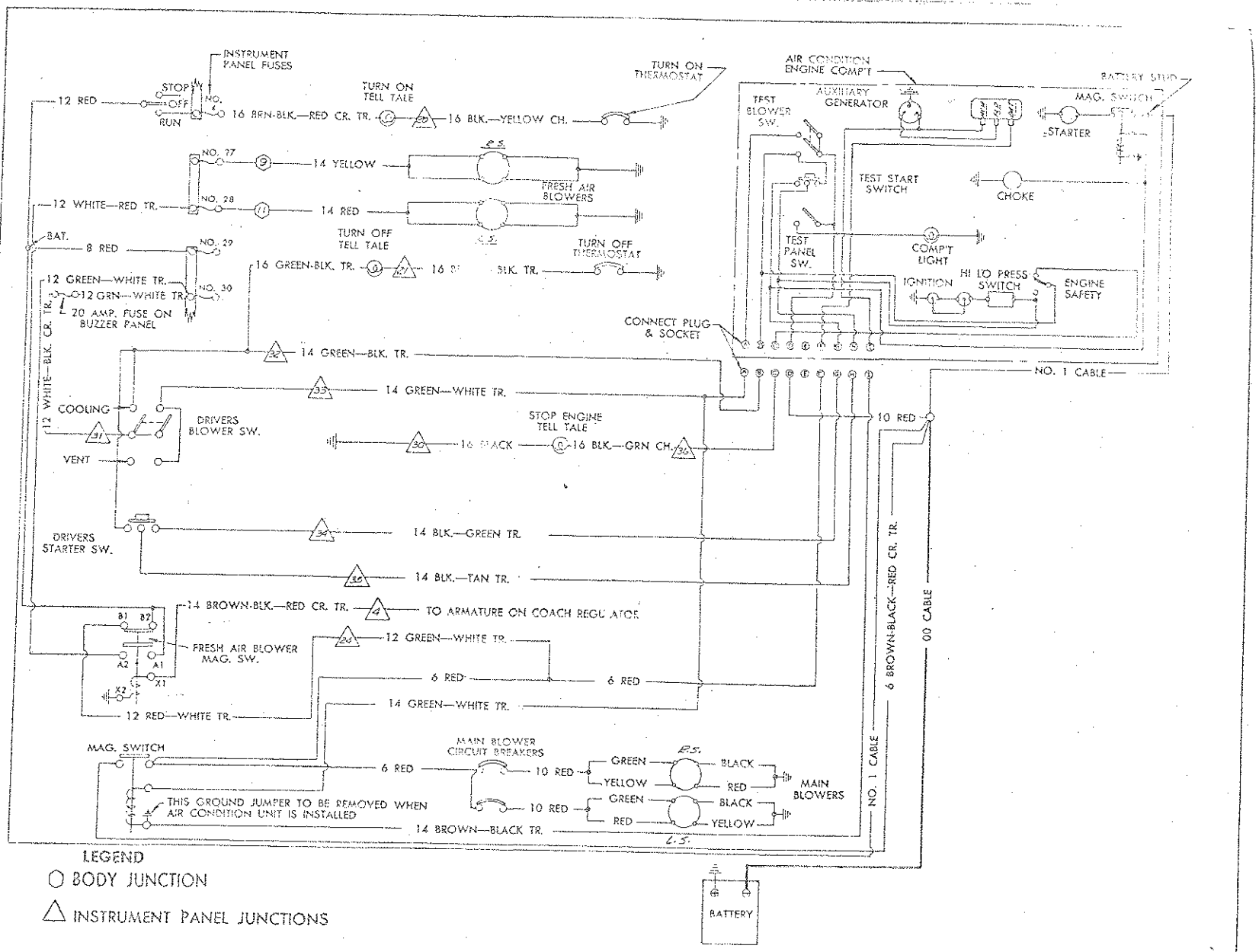


Figure 12—Heating and Ventilating Wiring Diagram (N.Y. Regulation)

Cooling System

Contents of This Section

Related Subjects in Other Sections

GENERAL

Cooling of engine is accomplished by means of a sealed cooling system (fig. 1) which utilizes a pressure valve located on the surge tank.

The valve maintains a slight pressure within the cooling system, when the engine is warmed up to normal operating temperature, thus raising the boiling point of the cooling liquid and reducing evaporation, which permits slightly higher engine operating temperature.

Surge tank, mounted as shown in figure 1, permits expansion of cooling liquid without loss from the system.

Economical operation of engine depends largely upon proper operating temperature being maintained. Adequate control of operating temperature during hot or cold weather is assured provided all units are properly maintained.

Cooling system preventive maintenance should be practiced. The problem of rust and corrosion damage should be eliminated by the prevention of formation of rust and corrosion rather than by the correction of rust clogged water passages through clean out methods or the replacement of damaged parts after cooling system is in trouble.

CIRCULATION (Refer to Figs. 1, 2, and 3)

Cooling liquid is drawn through radiator by water pump, force circulated through oil cooler and engine water jacket around cylinder bores, upward into cylinder head where cooling liquid circulates around exhaust valves and injectors, then back to radiator where it is cooled by action of fan.

1. Engine Warm-up Period. Thermostat, located in engine water outlet manifold, is closed and restricts flow of cooling liquid into radiator until minimum temperature (predetermined by calibration of thermostat) is reached. During this period circulation of cooling liquid is through engine, by-pass tube, and oil cooler. This arrangement directs warm water through the oil cooler, warming the lubricating oil, thus shortening the warm-up period.

2. Normal Operating Temperature. As cooling liquid nears normal operating temperature, thermostat opens gradually, permitting circulation through radiator as required to maintain proper operating temperature. As thermostat opens, permitting flow through radiator, pressure against by-pass valve, located at oil cooler water inlet, is reduced and by-pass valve spring closes valve, stopping flow through by-pass tube. This causes cooled water to flow through oil cooler thus cooling lubricating oil.

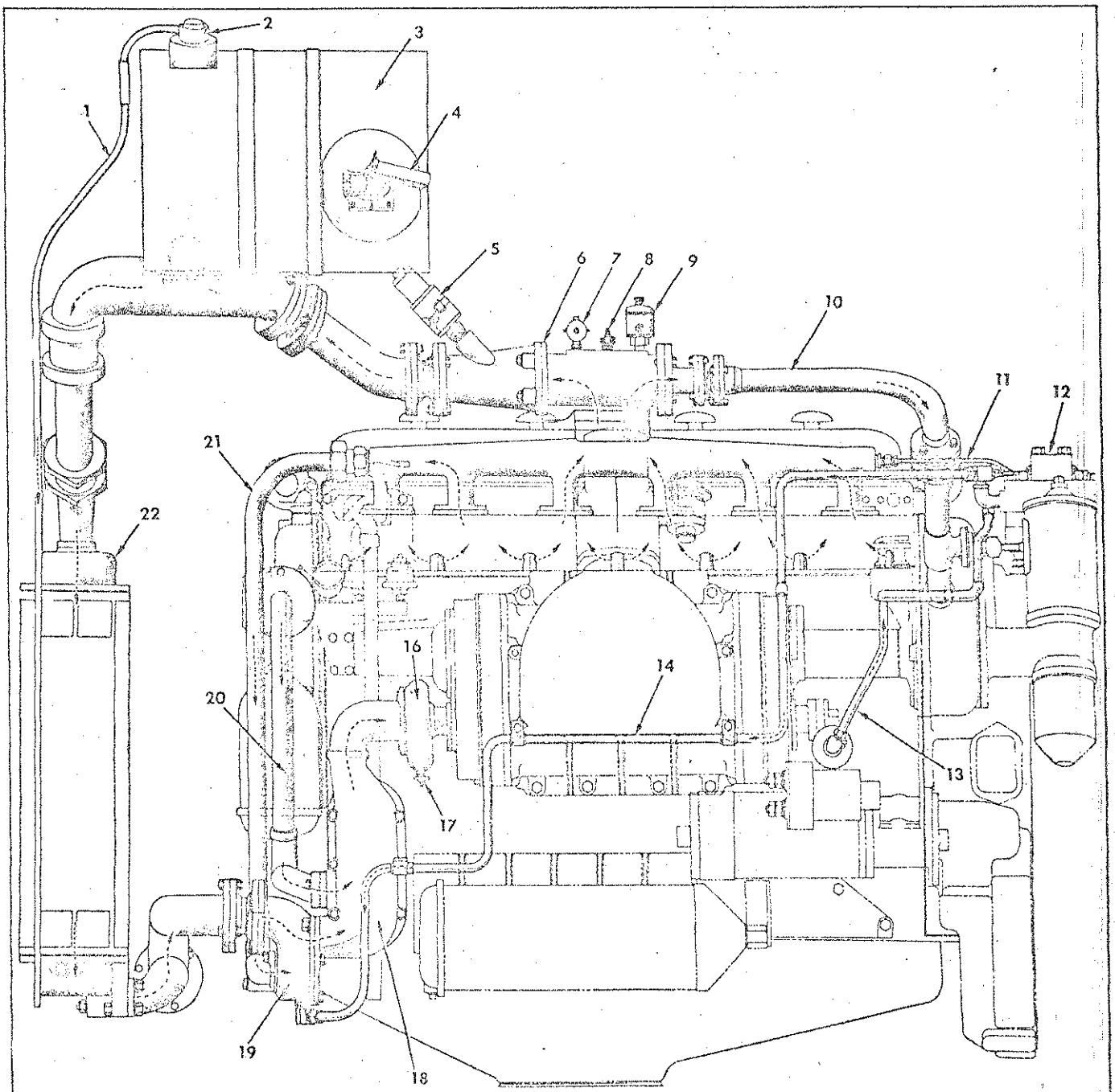
ENGINE OPERATING TEMPERATURE CONTROL

THERMOSTAT

Cooling system is designed to provide adequate cooling under the most adverse conditions; however, some device must be used to maintain operating temperature within a definite range and to prevent over-cooling during normal operation. This is accomplished by means of a thermostat in the engine water outlet to regulate the flow of the cooling liquid through the radiator.

Thermostat consists of a valve actuated by a thermostatic element and return spring. Valve starts to open at a predetermined temperature and continues to open gradually as temperature increases. Refer to "Specifications" at end of this section for operating temperature. Thermostat is not adjustable, its action being determined by the design of the element.

COOLING SYSTEM



1 Overflow Tube
2 Pressure Valve
3 Surge Tank
4 Radiator Filler
5 Radiator Shutter Thermostat
6 Thermostat Housing
7 Vent Cock
8 Temperature Gauge Engine Unit
9 Engine Overheat Thermostat
10 Heater Inlet Line
11 Air Compressor Vent Line
12 Air Compressor
13 Air Compressor Water Inlet Line
14 Air Compressor Water Outlet Line
15 Water Manifold
16 Water Pump
17 Drain Cock
18 Oil Cooler
19 By-Pass Valve Housing
20 Heater Return Line
21 Water By-Pass Tube
22 Radiator

TP 3380

Figure 1—General Arrangement of Cooling System Units

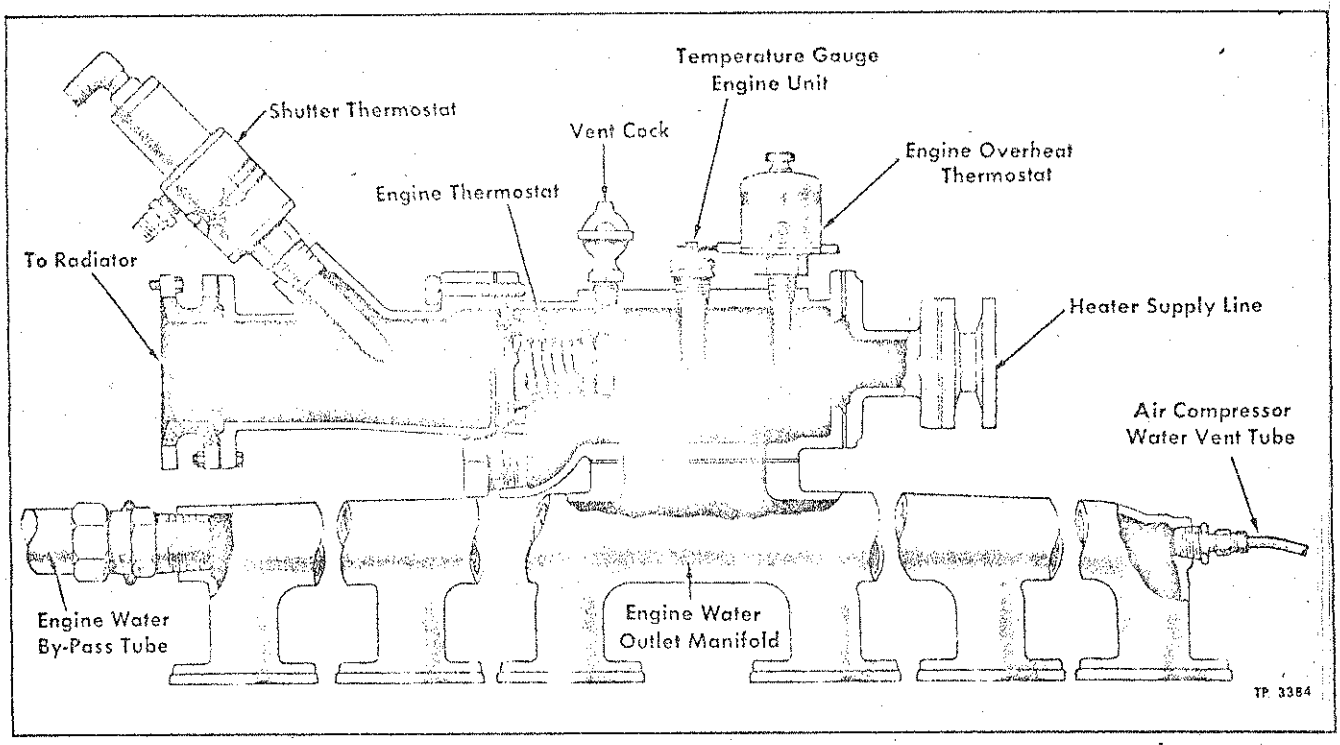


Figure 2—Sectional View of Engine Water Outlet Connection

Thermostat Maintenance

If action of the water temperature gauge, on instrument panel, indicates engine thermostat is fot functioning properly, remove thermostat and see if the component parts appear to be in good condition. If so, test action of assembly in water as follows:

Use a reliable thermometer to indicate temperature of water, also agitate water thoroughly at all times. Suspend thermostat in the water. Do not allow it to rest on bottom of container but be sure it is completely covered. Gradually heat water to opening temperature of thermostat valve, refer to "Specifications" at end of this section, then hold temperature of water there for two or three minutes to give thermostat an opportunity to react; then gradually increase temperature of water until fully opened temperature is reached.

Do not attempt to repair thermostat other than clean it of sludge, rust, or scale. If thermostat does not function properly, install a new one which has been checked as directed above and known to be functioning correctly. Use a new gasket when installing thermostat.

WATER TEMPERATURE INDICATOR

Water temperature indicator system consists of two electrically connected units; a sending unit mounted in engine water outlet and a registering gauge mounted on instrument panel.

System is interconnected with control switch as shown on Wiring Diagram (Sec. 7A of this manual) so that system is inoperative when control switch is in "OFF" position.

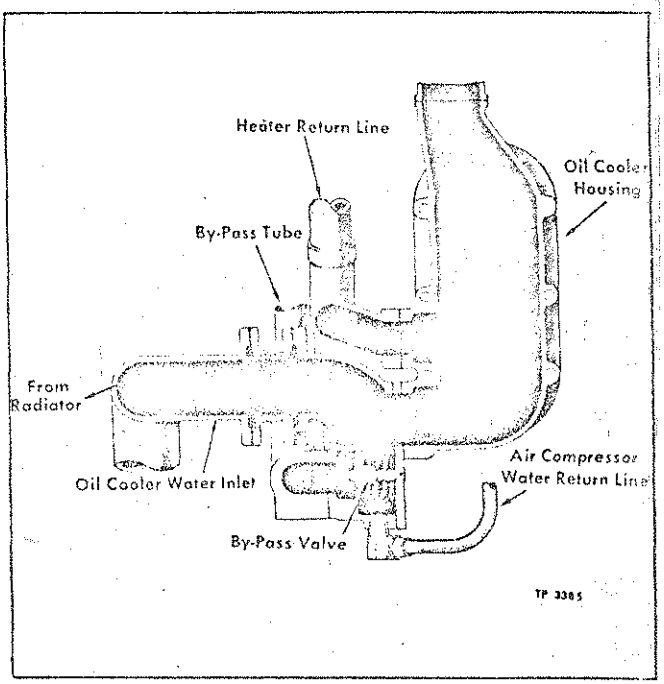


Figure 3—Sectional View of Oil Cooler Water Inlet

COOLING SYSTEM

Tests

If temperature gauge does not operate or show apparent false readings, with control switch turned on, check as follows:

1. Check No. 2 fuse to see if it is burned out.
2. If not, disconnect wire at engine unit terminal.
3. Connect one lead of a 1.5 candlepower 12-volt test lamp to battery terminal on starter solenoid. Touch other lead to body of engine sending unit. If bulb lights, unit is properly grounded. If bulb does not light, check for presence of sealing compound around threads of unit. Remove compound and repeat test.
4. Remove test lamp lead from body of unit, and touch lead to terminal on unit. If bulb lights engine unit is shorted and should be replaced.
5. Remove test lamp and reconnect wire from gauge unit to engine unit terminal.
6. Test wiring and units for current flow. Use test lamp as follows:

a. Connect one lead of test lamp to terminal on engine unit to which wire from control switch is connected. Connect other lead of test lamp to ground. If bulb fails to light, check wiring for open circuit.

b. Connect one lead of test lamp to gauge terminal to which engine unit si connected, and other lead to ground. If bulb fails to light, engine unit should be replaced.

c. Connect test lamp between other gauge terminal and ground. If bulb does not light, replace gauge.

7. If system still fails to function, trouble must be in the actuating elements of either the engine or gauge units or both and condition can be corrected by installing new unit in either or both of two positions.
8. Do not attempt to repair either engine or gauge units. When installing new engine unit do not use thread sealing compound on threads as this will increase electrical resistance of unit and cause faulty reading on gauge.

COOLING SYSTEM MAINTENANCE

Inspection of System

Systematic periodic inspection of units in cooling system is essential to maintain efficiency of system. Inspect at regular intervals as follows:

1. Check coolant in cooling system. Keep system filled to proper level. Check anti-freeze solution, if used.
2. Rust proof cooling system twice a year. Use a good chemically treated anti-freeze in the fall and a special rust preventive (inhibitor) with a fresh filling of water in the spring.
3. Check condition of all flexible couplings. Tighten or replace if necessary. Cracked, swollen, or deteriorated couplings should be replaced.
4. Check radiator core for leaks. Make certain that core is not clogged with dirt or insects. Clean out with compressed air, using low air pressure.
5. Inspect pump operation. A leaky water pump sucks in air which increases corrosion.
6. Repair all leaks. One drop of solution each ten seconds amounts to nearly one gallon lost in one week.
7. Inspect and tighten radiator mountings.
8. Test and replace thermostat if necessary. Bear in mind that causes of overheating in cooling system are not always traceable to defective operation of cooling units. Overheating causes originating from sources outside of the cooling system, are noted in Trouble Shooting (Sec. 21 of this manual).

Loss of Cooling Solutions

Solutions may be lost from cooling system through leaks, or overheating, which may be caused by.

1. "Hot spots" in rust and lime-clogged engine water jackets, causing steam which forces solution out surge tank overflow.
2. Air suction into system at leaky water pump or from low level in system.
3. Rust-clogged radiator.
4. Thermostat stuck in closed position.
5. Inoperative radiator shutters.

Draining and Filling Cooling System

Refer to Operation (Sec. O of this manual) for instructions on draining and filling cooling system.

Cleaning Cooling System

Unless water in cooling system is treated with a corrosion preventive, rust and scale will eventually clog water passages in radiator and jackets. This condition is aggravated in some localities by the formation of insoluble salts from water used.

Cleaning solutions are available which will successfully clean cooling systems of rust, scale, sludge, and grease, when used as directed by the manufacturer. However, if radiator is clogged with insuluble scale formations, reliable radiator service stations in the various localities are best equipped to remove such formations. Never use an alkaline type cleaner. Particularly at winter check-up, preferably before and after using anti-freeze solutions, radiator and entire cooling system should be cleaned with a reliable cleaning solution.

NOTE: Always follow instructions given by manufacturer of cleaning solution and equipment used.

Before pressure flushing cooling system, it is a good policy to tighten cylinder head bolts to prevent possible water leaks into cylinders and lubrication oil. Remove thermostat. Apply air gradually, as a clogged radiator will stand only limited pressure.

After cleaning operation is completed, be sure to check and test thermostat as described under "Thermostat." Clean out overflow pipe and blow insects and dirt from radiator air passages and grille.

GMC COOLING SYSTEM CLEANER

GMC Cleaner is especially developed to remove rust, scale, and corrision from the radiator and cylinder block water passages.

NOTE: Use cleaner only as instructed on label.

GMC COOLING SYSTEM SEALER

GMC sealer is very effective in stopping leaks in cylinder head, water jackets and radiator. Sealer may be used with any standard anti-freeze and will not clog water passages.

NOTE: Use sealer only as instructed on label.

CORROSION DAMAGES AND ITS PREVENTION

Water without an inhibitor not only causes corrosion in cooling system which interferes with circulation and cooling, but also corrosion damage to aluminum parts such as, upper and lower radiator tanks, radiator inlet and outlet fittings, engine water outlet manifold and possibly others to be added later. Some natural waters are highly corrosive to aluminum HENCE PREVENTIVE MEANS ARE EXTREMELY NECESSARY, particularly in the presence of ferrous metals (iron and steel).

Use of "soft," "deionized," or "distilled" water will aid greatly in reducing corrosion attack on aluminum parts and is recommended for use whenever possible.

Treatment of cooling system for the prevention of scale and rust formation has become an accepted automotive maintenance practice. This process consists of introducing into cooling system certain substances called "Inhibitors" which reduce or prevent corrosion of metals and deposition of scale, thus tending to maintain high cooling efficiency.

In general, inhibitors are not cleaners and will not remove scale and rust already formed. INHIBITORS SHOULD BE USED CONTINUOUSLY, preferably immediately after system has been thoroughly cleaned or when vehicle is new.

However, use of additional corrosion preventives or inhibitors is not recommended with "GM" or other anti-freeze preparations already containing an inhibitor, as an excessive amount may be harmful to rubber parts.

Following are the salient points concerning recommended inhibitors:

1. GMC Cooling System Corrosion Inhibitor

GMC inhibitor is a specially developed chemical water treatment designed to prevent excessive formation of corrosion and scale. GMC corrosion inhibitor should be used at all times with plain water, and with an uninhibited anti-freeze solution.

NOTE: Use inhibitor only as instructed on label.

2. Soluble Oil

Use only in plain water and in anti-freeze solutions which do not already contain an inhibitor, and in accordance with instructions issued by the soluble oil manufacturers; supply stations have available various soluble oil inhibitors. They are marketed under different names but their characteristics are similar.

When using soluble oil in plain water, or in uninhibited alcohol or methanol solutions, do not add too much. Soluble oil is not lost be evaporation and EXCESSIVE AMOUNTS ARE UNDESIRABLE; The amount of soluble oil in a cooling system syould never exceed 1% of the volume of the system. (See Anti-freeze Chart for capacity.)

3. Potassium Bichromate

Use only in plain water in proportion of two ounces of crystals to each five gallons of water. Potassium bichromate (dichromate) may be purchased from any drug or chemical house, or under a trade name at supply stations.

COLD WEATHER OPERATION

Plain water plus an inhibitor can be safely used as a cooling medium in climates where temperatures do not reach below 32°F. In cold regions, anti-freeze must be used.

Before installing anti-freeze solution, cooling system should be inspected and serviced for winter, as previously described under "Inspection" and "Cleaning Cooling System."

Cylinder head gaskets should be tightened or replaced, if necessary, to avoid possibility of anti-freeze solution leaking into engine and exhaust gases blowing into cooling system.

After anti-freeze solution has been installed, entire system should be inspected regularly to insure against development of leaks.

Thawing Cooling System

If cooling medium in system becomes frozen solid, place vehicle in warm building until ice is completely thawed out.

UNDER NO CIRCUMSTANCES SHOULD ENGINE BE RUN WHEN COOLING SYSTEM IS FROZEN SOLID.

COOLING SYSTEM

Anti-freeze Solution

Following information will assist in selecting anti-freeze solution best suited to meet individual driving conditions.

The most common commercial materials are:
Methanol (Methyl or Wood Alcohol)
Ethylene Glycol

Kerosene, Oils, or solutions containing calcium chloride, magnesium chloride, sodium silicate or other inorganic salts, honey, glucose, or sugar are not satisfactory for use in cooling system.

Methanol

Methanol is used extensively for anti-freeze solutions. Methanol anti-freeze solutions have the advantage of low first cost. There are, however, some disadvantages.

1. Methanol may be lost by evaporation, especially on warm days and on hard driving, and unless solution in radiator is tested periodically and sufficient anti-freeze added to replace loss, engine or radiator, or both, are liable to be damaged by subsequent freezing.

2. Vehicle finish may be damaged by contact with methanol solutions or vapors. Methanol accidentally spilled on finish should be flushed off immediately with large quantity of cold water without wiping or rubbing.

Ethylene Glycol

Ethylene glycol's first cost is usually higher than that of other types of anti-freeze. Ethylene glycol solutions, however, have the advantage of a higher boiling point and may be used at higher temperature, without loss, resulting in more efficient performance of cooling system. Ethylene glycol has the further advantage that in a tight system only water is required to replace evaporation losses. However, losses through leakage or foaming must be replaced by additional new solutions. Under ordinary conditions, ethylene glycol solutions are not injurious to body finish.

"GM Ethylene Glycol" is especially treated and compounded for use in cooling systems. Other ethylene glycol preparations are available, but only those containing suitable corrosion inhibitors and compounded for use in automotive cooling systems should be used, diluting them in accordance with instructions issued by the manufacturer.

Frequent inspection and test should be made for accidental leakage. If solution becomes brown or rusty colored, ocrrosion has taken place and solution should be immediately discarded and replaced with fresh solution,

Testing Anti-freeze Solution

Always test solution before adding water or anti-freeze. Engine should be warmed up to operating temperature. Fill and empty tester several times to warm tester before using. Keep tester clean inside and out.

Some testers will indicate correct freezing point only when test is made at a specific temperature.

Other testers are provided with thermometers and tables and indicate freezing points corresponding to readings made at various temperatures. Disregarding temperature of solution may cause an error as large as 30°F.

Some testing devices are made to test only one kind of anti-freezing solution. Others have several scales, and may be used for corresponding kinds of anti-freeze. Read, and be guided by, instructions furnished with tester.

MOTO-GARD AND TELL-TALE ALARM SYSTEM

Moto-Gard and tell-tale alarm system comprises a group of automatic electrical devices which prevent damage to engine due to loss of oil pressure or excessive coolant temperature by stopping the engine when either of these conditions occur. Operation of this system is explained in Operation (Sec. O of this manual). Maintenance and repair of units included in Wiring and Miscellaneous Electrical (Sec. 7A of this manual).

ANTI-FREEZE CHART
ALL QUANTITIES LISTED IN QUARTS
(76 Quarts Total Capacity)

Temperature	Methanol	Ethylene Glycol
+ 10 F.	19	19
0 F.	24	25
- 10 F.	28	29
- 20 F.	33	33
- 30 F.	38	36

COOLING SYSTEM CAPACITY

Engine, Radiator, Pipes and Fittings	62 qts.
Heating System	14 qts.

SPECIFICATIONS

THERMOSTAT - WATER CIRCULATION	
Starts to Open	168°F.
Fully Opened	195°F.
TEMPERATURE GAUGE	
Make	King Seeley
Type	
Gauge Unit	41245
Engine Unit	B-7000
Operating Range	100° - 212°F.
Voltage	6

Radiator and Shutter

Contents of This Section

Related Subjects in Other Sections

Subject	Page
Air Brakes	87
Cooling System	129
Fan and Water Pump	139
Engine Tune-up	191
Engine	193
Trouble Shooting	265

RADIATOR

Radiator is mounted on left side of vehicle in front of engine and is accessible through the radiator grille door. Surge tank, mounted in the upper left section of engine compartment, permits expansion of cooling liquid without loss from overflow. Excessive liquid or vapor in cooling system is exhausted through pressure valve and overflow tube which extends down side of radiator core.

The radiator is designed to cool the water under all operating conditions; however radiator core must be kept free from corrosion and scale at all times in addition to the maintenance of other cooling units in order to obtain satisfactory service.

Cleaning of radiator, inspection of connections and mountings, and use of corrosion preventives are essential periodic service procedures.

Radiator core should be periodically cleaned inside and out in a cleaning solution. At the same time, examine core for leaks and bent tubes, and repair if necessary. If radiator core requires painting, spray with special radiator paint. Do not use paint mixed with oil, as this type will form an insulation on core and prevent dissipation of heat.

RADIATOR REMOVAL

If necessary to remove radiator core for repair operations when power plant is in the chassis, proceed as follows:

1. Drain system. Drain cock is located at bottom radiator outlet connection.
2. Raise radiator grille door and secure with chain at rear quarter panel.
3. Disconnect air cylinder.
4. Remove shutters.
5. Disconnect radiator outlet hose.
6. Remove oil reservoir, then disconnect radiator inlet hose.

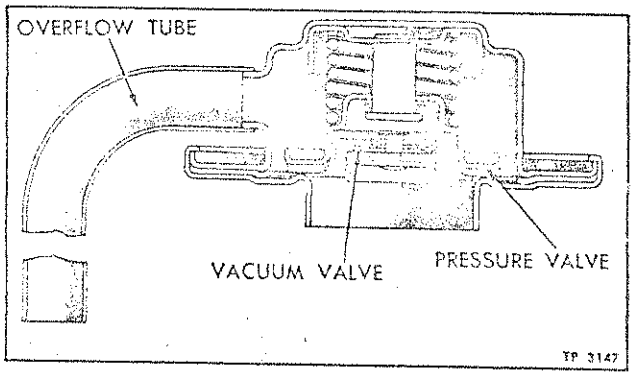


Figure 1—Sectional View of Surge Tank Pressure Valve

7. Remove radiator support bolt nuts, one on each side at top.
8. Disconnect radiator tie-rod at bottom of radiator.
9. Remove radiator and shroud assembly straight out through radiator grille openings.
10. Shroud can now be removed from radiator.

SURGE TANK PRESSURE VALVE (Fig. 1)

A valve incorporating a pressure valve and a vacuum valve is used to seal the cooling system. The valve is located on the surge tank and maintains a pressure of approximately 4 lbs. within the cooling system when the engine has warmed up to normal operating temperature. Steam or vapor can escape from the cooling system, when necessary, through the pressure valve while the purpose of the vacuum valve is to permit atmosphere to enter the cooling system when cooling liquid contracts. The increased pressure within the cooling system raises the boiling point of the cooling liquid permitting a slightly higher engine operating temperature which results in improved engine performance and economy without danger of over-heating.

RADIATOR AND SHUTTER

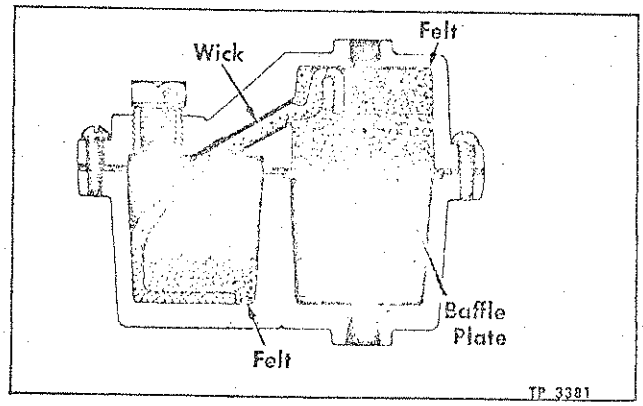


Figure 2—Sectional View of Radiator Shutter Air Filter

Pressure valve also reduces evaporation of cooling liquid and prevents its surging into upper tank after engine has been stopped following a hard drive in hot weather.

RADIATOR SHUTTER

Radiator shutter and controls combine thermostatic control with air power actuation. With this arrangement, radiator shutter operating linkage is connected to an air chamber. Operation of air chamber is controlled by a thermostat in water line between engine and radiator. Thermostat is set to open and close at temperatures noted in "Specifications" section.

RADIATOR SHUTTER ASSEMBLY

Maintain radiator unit in free working condition by cleaning vane bearings thoroughly with brush or spray gun, or both. Use gasoline or penetrating oil until all dirt is removed. After shutter is once worn in, lubricating oil may be omitted after cleaning. Frictional wear is very slight, and excessive lubricant may increase rapid collection of dirt. This attention is recommended every 2000 or 5000 miles. depending upon the nature of operation and the tending toward dirt collection.

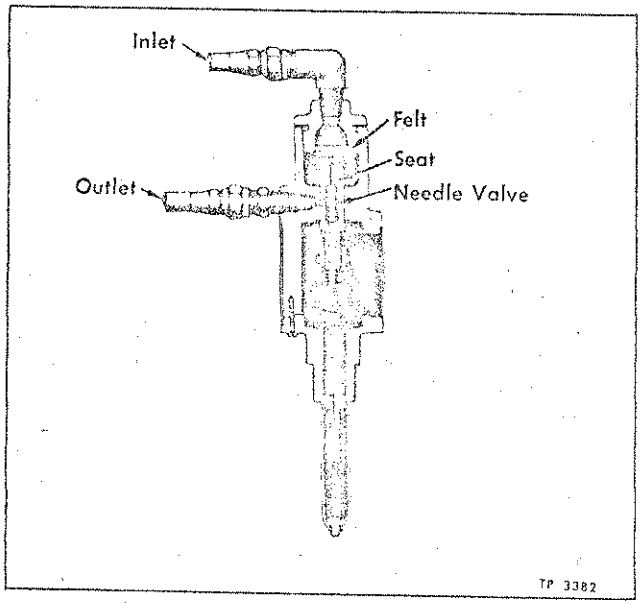


Figure 3—Sectional View of Radiator Shutter Thermostat

AIR FILTER

Air filter, shown in (figure 2), prevents moisture from entering shutter thermostat. As air from air tank enters filter, it strikes against baffle which diverts moisture in air stream to bottom of housing. Air then passes through felt filtering element. Air is again filtered through felt before entering thermostat air valves. Periodic check should be made for leakage at filter connections. Tighten if necessary. With felt inserted, air filter chamber holds slightly over one ounce of fluid.

Add fluid to filter through filler plug. Refer to Lubrication Chart for intervals, quantity and type of fluid to use. Larger quantities or more frequent filling may overload system.

Air filter should be drained at intervals shown in Lubricating Chart by opening pet cock at bottom. This operation should be performed under pressure.

Every 10,000 miles, air filter should be disassembled and the felt cleaned with cleaning solvent or replaced.

RADIATOR SHUTTER THERMOSTAT

Thermostat, shown in figure 3, functions automatically according to engine temperature, opening and closing air line to the air chamber which in turn operates the radiator shutter.

At periodic intervals thermostat must be cleaned by disconnecting inlet line and injecting a cleaning fluid into the thermostat. Refer to Lubrication Chart for intervals, quantity, and type of fluid to use. When air line is reconnected pressure will force fluid through thermostat needle valve cleaning away any deposits of foreign matter.

Thermostat should be disassembled and cleaned once or twice per year. Disassemble by removing end caps and needle valve upper seat. Wash needle valve thoroughly in a reliable solvent. Do not use any abrasive or metal tools in removing deposits from needle valve or seats. A pointed wooden stick provides a practical method of cleaning tapered seats. Care must be taken to have all parts thoroughly cleaned before reassembling. Felts must be renewed or thoroughly washed in solvent not neglecting small felts found in side openings.

Testing Thermostat

When thermostat is completely assembled except for base and cover, needle travel should be measured accurately and set to .005" - .006" by using a dial indicator.

After complete reassembly, test and reset thermostat to assure correct operation. This can be done by using portable tester such as listed under "Special Tools" at end of this section. This tester has an electric heating unit, a circulating water pump, and attachments to duplicate actual conditions which exist when the thermostat is installed in the engine. Thermostat is inserted in tester and line protruding from top of tester is connected to end of thermostat. Air line to pressure gauge is connected to side of thermostat. After connecting electric cord and air line to tester and filling tester with water at cup at right side, the instrument is ready for use. The switches at right control electric heating unit and circulating pump, and the pressure gauge will indicate points at which thermostatic valve acts. By moving the adjusting nut in or out, the setting can be made accurately so that, when placed in the engine, the shutter will open and close at the desired temperature. See "Specifications" at end of this section.

AIR CHAMBER

Air chamber, shown in figure 4, is controlled by the thermostat and automatically opens and closes radiator shutter according to engine temperature.

Air Chamber Serviceability Tests

1. Operation. With maximum pressure in air system and engine temperature below normal operating temperature, shutter should be closed. When engine temperature reaches normal operating temperature shutter should open.

2. Leakage. With maximum pressure in air system and shutter closed, coat, with soap suds, the bolting flanges holding the diaphragm in place between the pressure plate and the non-pressure plate. No leakage is permissible. If leakage is evident, tighten flange bolts. NOTE: All flange bolts must be tightened evenly and only sufficiently to prevent leakage, otherwise the diaphragm will become distorted and premature failure will result.

Also, with maximum pressure in air system and engine temperature below normal operating temperature, check for leakage through diaphragm by coating the clearance hole around the push rod and the drain holes in the non-pressure plate with soap suds. No leakage is permissible. If leakage is evident, the diaphragm must be replaced.

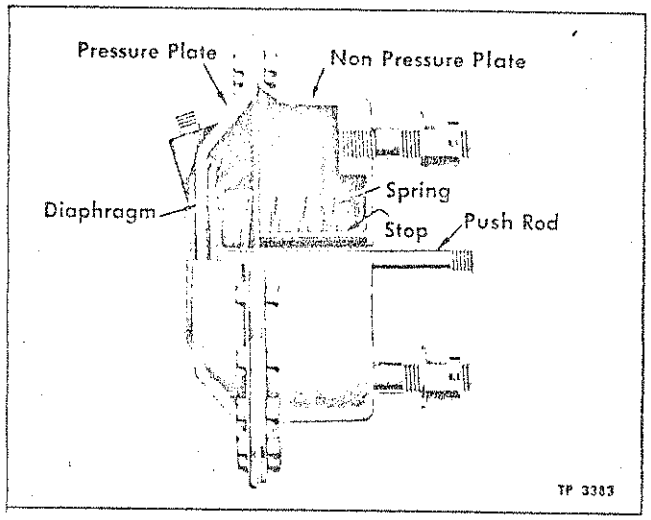


Figure 4—Sectional View of Radiator Shutter Air Chamber

Air Chamber Diaphragm Replacement
(Refer to Fig. 4)

Before disassembling air chamber, mark pressure plate and the non-pressure plate so that the air inlet opening in the pressure plate can be reassembled in the correct relationship to the non-pressure plate.

When installing diaphragm be sure to place diaphragm in pressure plate with edges of diaphragm inside of cupped flange of pressure plate, then assemble pressure and non-pressure plates in correct relationship as marked at time of disassembly.

As stated under "Serviceability Tests" tighten flange bolts only tight enough to insure an air tight seal but not enough to distort the diaphragm.

SPECIFICATIONS

SURGE TANK PRESSURE VALVE

Valve opens (Pressure in Pounds per sq. in.)	3-1/2 - 4-1/2

RADIATOR

Type	Finn and Tube
Frontal Area	858 Sq. in.
Thickness	4 in.

RADIATOR SHUTTER THERMOSTAT

Make	Kysor
Valve Closes at	180°F.

RADIATOR AND SHUTTER

SPECIAL TOOLS

Reference is made to special tools in this section. These tools, or their equivalent, are necessary and are recommended to more readily and efficiently accomplish certain service operations. The tools, however, are not supplied by GMC Truck & Coach Division. Names and addresses of vendors or manufacturers are shown as a reference, and since such vendors are the suppliers of these tools, information regarding availability, price, etc., should be obtained directly from them.

Name of Tool
Shutter Thermostat Dial Indicator
Shutter Thermostat Testing Unit

Vendor
Kysor Heating Company. . . . . Detroit, Mich.

SERVICE BULLETINS

Service Bulletins are issued, whenever required, supplementing information in this section. The information contained in these bulletins should be noted in the text and bulletin filed for future reference--Make note of bulletin number in space below:

NOTES

Fan and Water Pump

Contents of This Section

Related Subjects in Other Sections

FAN AND DRIVE

Fan assembly is mounted to engine crankshaft front cover by means of bracket, as shown in figure 1, and is driven from crankshaft pulley by pair of matched belts.

Fan blade spacer is bolted to fan drive pulley which revolves on double row ball bearing, inner race of which is secured to fan drive spindle by a nut and lock. Outer race of bearing is held in pulley by fan spacer as shown in figure 1. A lip type oil seal, pressed into pulley, wipes

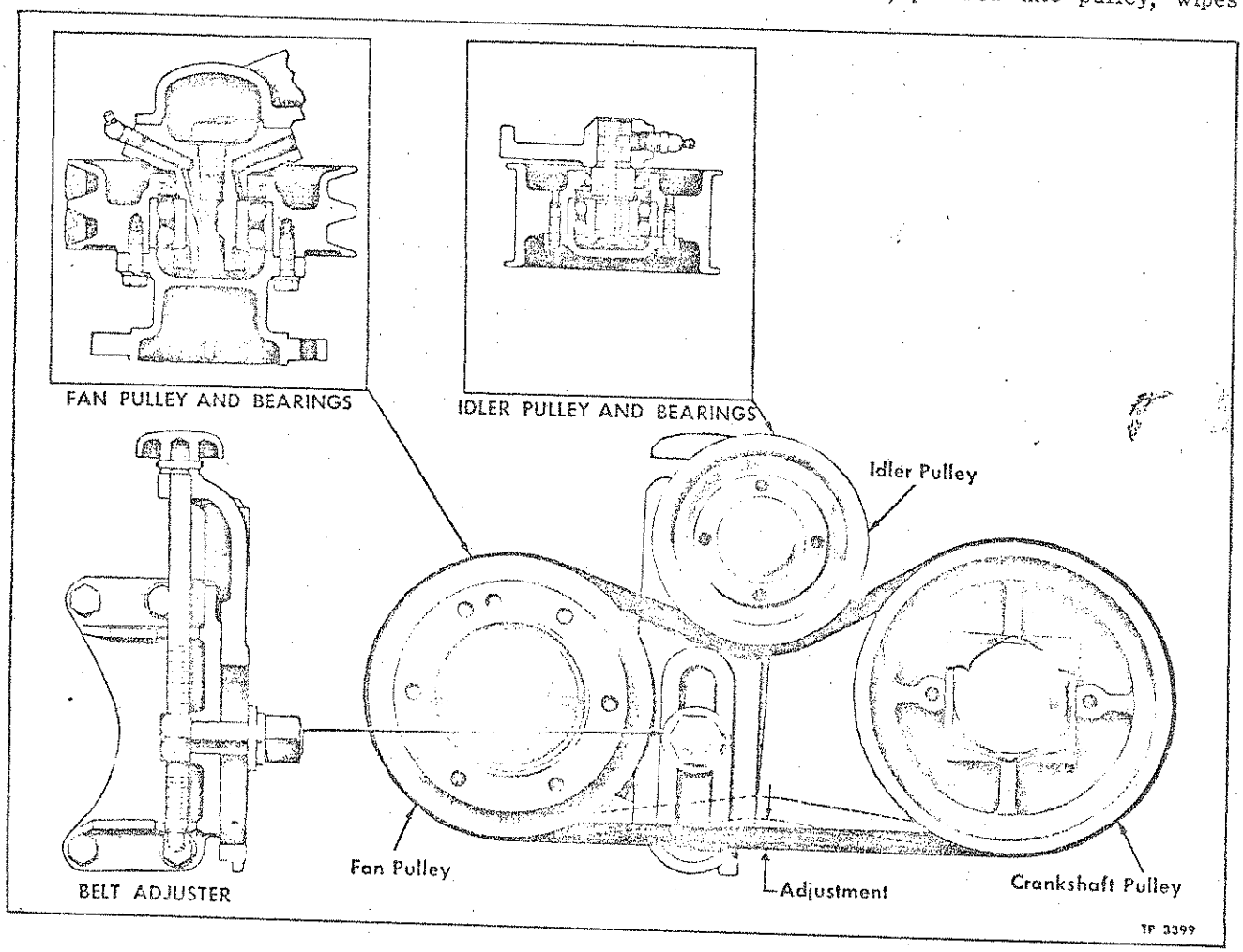


Figure 1—Fan and Drive

FAN AND WATER PUMP

on spindle to retain lubricant in bearing. A relief hole is provided in spindle to relieve excess lubricant. Lubricate as described in Lubrication (Sec. 13 of this manual).

FAN IDLER PULLEY

Fan idler pulley, mounted as shown in figure 1, revolves on a double row ball bearing, inner race of which is secured to shaft by nut and lock. Shaft is a press fit in idler pulley bracket. Bearing outer race is held in pulley by a retainer bolted to pulley. A lip type oil seal, pressed into pulley, wipes on shaft to retain lubricant in bearing. A relief hole is drilled in shaft to relieve excess lubricant. Lubricate as directed in Lubrication (Sec. 13 of this manual).

FAN BELT ADJUSTMENT

To adjust fan belt, loosen idler pulley bracket clamp bolt nut; then turn idler pulley adjusting screw handle as necessary to adjust belt so that a light pressure on belt, midway between pulleys, will cause 1/2 to 3/4 inch deflection as shown in figure 1. Be sure to tighten clamp bolt nut after belt adjustment is completed.

WATER PUMP

Description and instructions for maintenance of water pump used in Diesel engine equipped vehicles are contained in separate maintenance manual for Diesel engine (Form X-4517).

SPECIFICATIONS

FAN

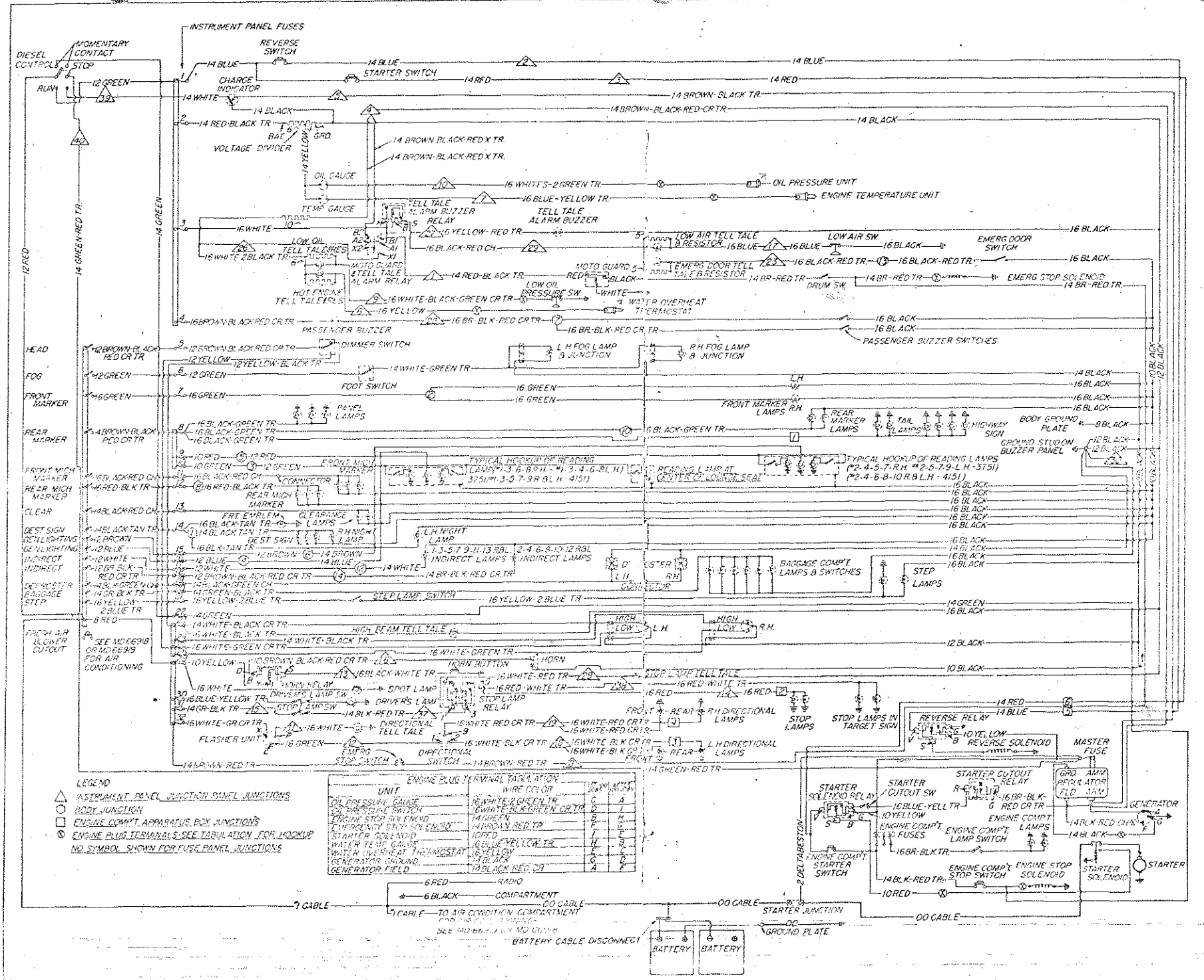
Drive	Crankshaft
Number of Blades	6
Diameter	26"
Rotation	Counterclockwise

WATER PUMP
(See Diesel Engine Maintenance Manual).

SERVICE BULLETINS

Service Bulletins are issued, whenever required, supplementing information in this section. The information contained in these bulletins should be noted in the text and bulletin filed for future reference - Make note of bulletin number in space below:

NOTES


INSTRUMENT PANEL FUSES
DIESEL CONTROL
MOMENTARY CONTACT
STOP
RUN
REVERSE SWITCH
CHARGE INDICATOR
STARTER SWITCH
14 BLUE
14 RED
14 WHITE
14 BLACK
14 BROWN-BLACK-RED-CR TR
14 BROWN-BLACK TR
14 RED-BLACK TR
12 GREEN
12 RED
14 GREEN-RED TR
14 GREEN
VOLTAGE DIVIDER
BAT
GRD
14 YELLOW
14 BROWN BLACK-RED X TR
14 BROWN-BLACK-RED X TR
OIL GAUGE
TEMP GAUGE
16 WHITE-5-2 GREEN TR
OIL PRESSURE UNIT
16 BLUE-YELLOW TR
ENGINE TEMPERATURE UNIT
TELL TALE ALARM BUZZER RELAY
TELL TALE ALARM BUZZER
16 WHITE
16 YELLOW-RED TR
16 BLACK-RED CH
LOW OIL TELL TALE RELAY
16 WHITE-2 BLACK TR
MOTO GUARD & TELL TALE ALARM RELAY
14 RED-BLACK TR
HOT ENGINE TELL TALE LTS
16 WHITE-BLACK-GREEN CR TR
LOW OIL PRESSURE SW
WATER OVERHEAT THERMOSTAT
16 YELLOW
16 BROWN BLACK-RED CR TR
PASSENGER BUZZER
16 BR-BLK-RED CR TR
LOW AIR TELL TALE & RESISTOR
LOW AIR SW
16 BLUE
16 BLACK
EMERG DOOR SWITCH
EMERG DOOR TELL TALE & RESISTOR
16 BLACK-RED TR
14 BR-RED TR
DRUM SW
EMERG STOP SOLENOID
PASSENGER BUZZER SWITCHES
HEAD
FOG
FRONT MARKER
REAR MARKER
CLEAR
DEST SIGN
GEN LIGHTING
INDIRECT
DEFROSTER
BAGGAGE
STEP
12 BROWN-BLACK RED CR TR
DIMMER SWITCH
12 YELLOW
12 YELLOW-BLACK TR
L H FOG LAMP & JUNCTION
R H FOG LAMP & JUNCTION
FOOT SWITCH
14 WHITE-GREEN TR
16 GREEN
LH
RH
16 BLACK
PANEL LAMPS
FRONT MARKER LAMPS R.H.
REAR MARKER LAMPS
TAIL LAMPS
HIGH WAY SIGN
BODY GROUND PLATE
GROUND STUD ON BUZZER PANEL
8 BLACK
12 BLACK
16 BLACK-GREEN TR
TYPICAL HOOKUP OF READING LAMP (*1-3-6-8 R.H. - *1-3-4-6 L.H. - 3751/PI 3-5-7-9 R & L.H. - 4151)
READING LAMP AT CENTER OF LOWEST SEAL
TYPICAL HOOKUP OF READING LAMPS (*2-4-5-7 R.H. *2-5-7-9 L.H. -3751) (*2-4-6-8 R & L.H. - 4151)
FRONT HIGH MARKER
REAR HIGH MARKER
16 BLACK-RED CH
16 RED-BLK TR
CONNECTOR
14 BLACK-RED CH
FRT EMBLEM CLEARANCE LAMPS
DEST SIGN
R.H. NIGH LAMP
L.H. NIGHT LAMP
16 BLACK-TAN TR
14 BLACK-TAN TR
1-3-5-7 9-11-13 RR INDIRECT LAMPS
2-4-6-8-10-12 RR INDIRECT LAMPS
14 BROWN
14 BLUE
12 BLUE
12 WHITE
12 BR BLK-RED CR TR
14 BR-BLK-RED CR TR
14 GREEN-BLK TR
14 BLACK-GREEN CH
16 YELLOW-2 BLUE TR
STP LAMP SWITCH
BAGGAGE COMP'T LAMPS & SWITCHES
STEP LAMPS
16 GREEN
14 GREEN
8 RED
FRESH AIR BLOWER CUTOUT
SEE MD66918 OR MD66919 FOR AIR CONDITIONING
14 WHITE-BLACK CR TR
16 WHITE-BLACK TR
16 WHITE-GREEN CR TR
HIGH BEAM TELL TALE
HIGH
LOW
L.H.
R.H.
16 WHITE-GREEN TR
12 BLACK
10 YELLOW
10 BROWN BLACK-RED CR TR
HORN BUTTON
HORN
10 BLACK
16 BLACK-WHITE TR
HORN RELAY
16 WHITE-RED TR
16 RED-WHITE TR
STOP LAMP TELL TALE
16 WHITE
SPOT LAMP
16 BLUE-YELLOW TR
DRIVER'S LAMP SW
DRIVER'S LAMP
14 GR-BLK TR
STOP LAMP SW
STOP LAMP RELAY
14 BLK-RED TR
16 RED
FRONT
REAR
R.H. DIRECTIONAL LAMPS
STOP LAMPS
STOP LAMPS IN TARGET SIGN
REVERSE RELAY
14 RED
14 BLUE
10 YELLOW
REVERSE SOLENOID
MASTER FUSE
16 WHITE-GR CR TR
16 WHITE-RED CR TR
16 WHITE-BLK CR TR
DIRECTIONAL TELL TALE
DIRECTIONAL SWITCH
FLASHER UNIT
16 GREEN
EMERG STOP SWITCH
L.H. DIRECTIONAL LAMPS
14 BROWN-RED TR
14 GREEN-RED TR
STARTER SOLENOID RELAY
STARTER CUTOUT SW
STARTER CUTOUT RELAY
GRD AMM REGULATOR FLD ARM
GENERATOR
16 BLUE-YELL TR
16 BR-BLK-RED CR TR
ENGINE COMP'T FUSES
ENGINE COMP'T LAMP SWITCH
ENGINE COMP'T LAMPS
14 RLK-RED CH
14 BL ACK
16 BR-BLK TR
ENGINE COMP'T STARTER SWITCH
ENGINE COMP'T STOP SWITCH
ENGINE STOP SOLENOID
STARTER SOLENOID
STARTER
14 BLK-RED TR
10 RED
2 DELTABESTON
LEGEND
INSTRUMENT PANEL JUNCTION PANEL JUNCTIONS
BODY JUNCTION
ENGINE COMP'T APPARATUS BOX JUNCTIONS
ENGINE PLUG TERMINALS-SEE TABULATION FOR HOOKUP
NO SYMBOL SHOWN FOR FUSE PANEL JUNCTIONS
ENGINE PLUG TERMINAL TABULATION
UNIT
WIRE COLOR
OIL PRESSURE GAUGE
OIL PRESSURE SWITCH
ENGINE STOP SOLENOID
EMERGENCY STOP SOLENOID
STARTER SOLENOID
WATER TEMP GAUGE
WATER OVERHEAT THERMOSTAT
GENERATOR GROUND
GENERATOR FIELD
16 WHITE-2 GREEN TR
6 WHITE-BLK-GREEN CR TR
14 GREEN
14 BROWN-RED TR
10 RED
16 BLUE-YELLOW TR
16 YELLOW
14 BLACK
14 BLACK-RED CH
6 RED
RADIO
6 BLACK
COMPARTMENT
7 CABLE
00 CABLE
TO AIR CONDITION COMPARTMENT
BATTERY CABLE DISCONNECT
STARTER JUNCTION
GROUND PLATE
BATTERY
BATTERY

Wiring and Miscellaneous Electrical

Contents of This Section

Related Subjects in Other Sections

Subject	Page	Subject	Page
Operation	13	Generator	167
Body	63	Regulator	175
Brakes	87	Lighting System	185
Battery	155	Engine Tune-Up	191
Starter	157	Trouble Shooting	265

ng diagram (fig. 1) illustrated in this shows all standard electrical units and . Position of electrical units is shown atically.

ıg diagrams covering heating and ventilation found in Body (Sec. 3B of this manual).

Additional wiring diagrams covering special equipment units will be found in other sections of this manual in which equipment is covered.

A com; lete list of all electrical and mechanical control units, etc., and function of each are given in Operation (Sec. O, of this manual).

INDEX OF ELECTRICAL UNITS

ain electrical equipment is covered in ections of this manual. Both electrical r sections describe and illustrate various al units. Service information and test ations are given in each section as follows:

	Sec.	Page
r	7A	142
	7B	157
Passenger	3B	63
roster	3B	63
	7A	143 - 153
)il Pressure	8B	193
Water Temperature	6A	129
)r	7G	185
System	3B	63
	7A	146
System	7G	185
rd	7A	151
)r	7F	175
Horn	7A	147
Moto-Gard & Tell-Tale	7A	152
everse Solenoid	17	235
tarter Cut-Out	7C	157

UNIT	Sec.	Page
Switch, Emergency Stop	8B	173
Switch, Low Air Pressure	7A	148
Switch, Low Oil Pressure	7A	150
Switch, Moto-Gard Cut-Out	7A	152
Switch, Passenger Buzzer	3B	63
Switch, Reverse	17	235
Switch, Starter	7C	157
Switch, Stop Light	7G	185
Thermostat, Water Overheat	7A	151
Relay, Starter Solenoid	7C	157
Relay, Stop Light	7G	185
Relay, Tell-Tale Alarm Buzzer	7A	150
Resistor, Emergency Door Tell-Tale	7A	152
Resistor, Low Air Tell-Tale	7A	152
Resistor, Low Oil Pressure	7A	152
Resistor, Water Overheat Thermostat Tell-Tale	7A	152
Solenoid, Emergency Stop	8B	193
Solenoid, Reverse	17	235
Solenoid, Starter	7C	157
Starter	7C	157
Switch, Control	O	13
Switch, Emergency Door	3B	63

WIRING AND MISC. ELEC.

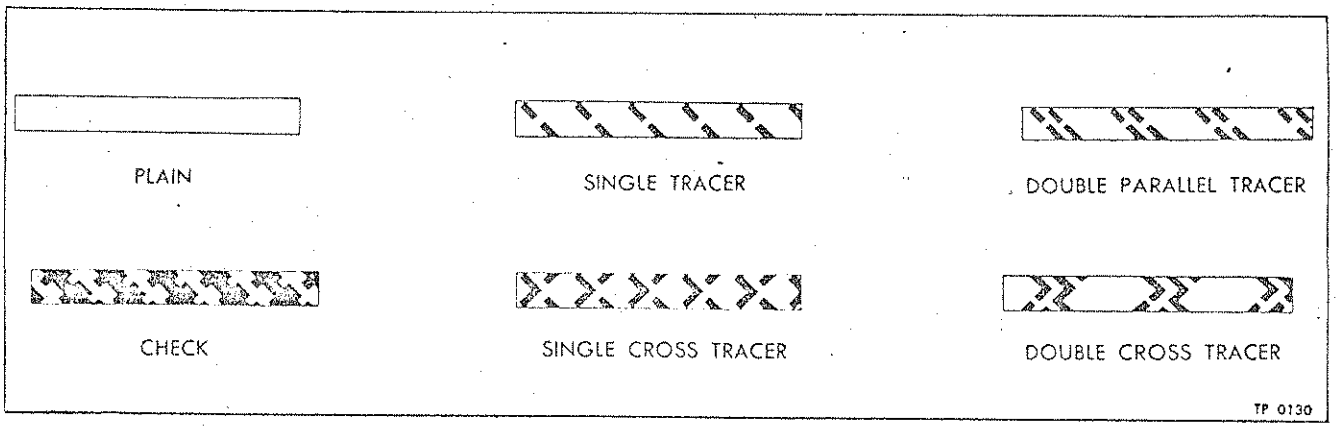
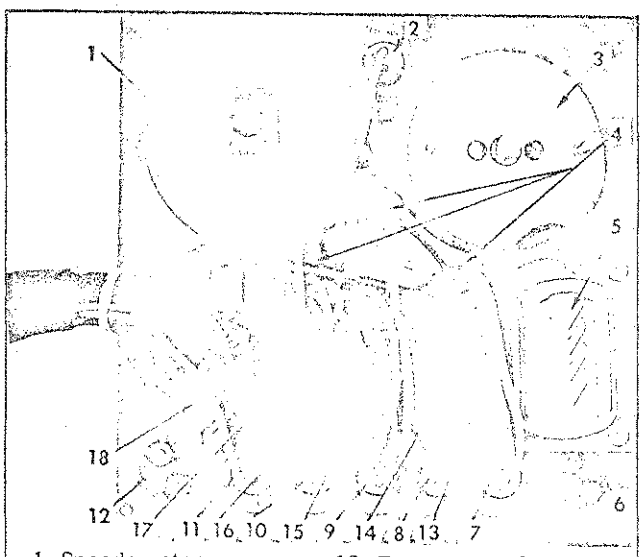


Figure 2—Wire Tracing Chart

TESTING CIRCUITS

Methods of testing various circuits are described in respective sections. However, circuits [illegible] tested for continuous circuit or shorts with test light or low-reading voltmeter.

All electrical connections must be clean and tight. Loose and corroded connections will cause run-down battery, difficult starting, dim lights, and improper function of electrical units. Inspect all wiring and connections at regular intervals. Refer to other sections listed above for maintenance instructions on various units and circuits.



1 Speedometer
2 Headlight Hi-Beam Tell-Tale
3 Air Pressure Gauge
4 Instrument Lights
5 Alarm Buzzer
6 Starter Button
7 Hot Engine Tell-Tale
8 Low Air Tell-Tale
9 Low Oil Tell-Tale
10 Emergency Door Tell-Tale
11 Stop Light Tell-Tale
12 Emergency Stop Button
13 Oil and Temperature Gauge Resistor
14 Low Oil and Water Overheat Alarm Resistor
15 Low Oil Tell-Tale Resistor
16 Water Overheat Tell-Tale Resistor
17 Emergency Door Tell-Tale Resistor
18 Low Air Tell-Tale Resistor

Figure 3—Rear View of Driver's Gauge Panel

WIRE SIZES AND TRACER COLORS

Each wire in electrical system is of a specific size as designated on wiring diagrams. When replacing wires, correct size as indicated must be used.

The insulation of each wire is distinctly patterned and colored to assist in tracing and testing circuits also in making correct connections.

Tracing colors are designated on each wire on diagram and the pattern chart (fig. 2) will serve to identify patterns.

DRIVER'S GAUGE PANEL

A driver's gauge panel is mounted in an easily visible position at front of driver. Refer to Operation (Sec. O of this manual) for operating instructions. The panel contains the following gauges, switches and lights.

Gauges & Switches	Tell-Tale Lights
Air Pressure Gauge	Headlight High Beam
Oil Pressure Gauge	Hot Engine
Water Temp. Gauge	Low Air
Gen. Charge Indicator	Low Oil
Starter Button	Emergency Door
Emergency Stop Button	Stop Lamp
Speedometer	

In addition to the above units on the face of the panel, there are six resistor units and an alarm buzzer mounted on the rear of the panel (fig. 3).

FUSE PANEL

A fuse panel is mounted on dash at front of vehicle. Fuses on this panel are easily accesible by opening a door, which is unlocked with the door wrench. Each fuse is numbered for easy identification. Spare fuses of various ampere capacity are mounted on rear of fuse panel door. When necessary to replace a blown fuse select a spare of the same size which insures the proper amperage. Refer to wiring diagram (fig. 1) for identification of various circuits and fuse numbers. Fuse panel, with door open, is illustrated in figure 4 while fuse panel junctions are shown in figure 5.

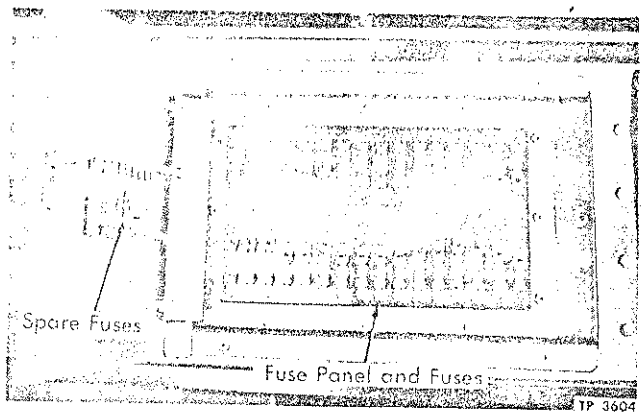


Figure 4—Fuse Panel

The following tabulation lists fuse number, amperage, circuit and wire size and color:

Fuse No.	Amperes	Circuit	Wire Size and Color
1	20	Reverse and Starter Switches	No. 14 Blue
	—	Feed to #1 to #4 Buss Bar	No. 12 Green
2	14	Oil Pressure and Water Temperature Gauges	No. 14 Red-Black Tr.
3	14	Tell-Tale Alarm Relay Feed	No. 16 White
4	14	Passenger Buzzer	No. 16 Brown-Bl. Red Cr. Tr.
5	20	Head Light Dimmer Switch Feed	No. 12 Brown-Bl. Red Cr. Tr.
6	14	Fog Light Foot Switch Feed	No. 12 Green
7	9	Front Corner Marker Lights	No. 16 Green
8	—	#8 to #10 Buss Bar Feed	No. 4 Brown-Bl. Red Cr. Tr.
	20	Instrument Panel, Rear Marker, Tail and Target Sign Lights	No. 16 Black-Green Tr.
9	30	Reading Lights (2,4,5,7 R.H. and 2,5,7,9 L.H.)	No. 10 Red
10	30	Reading Lights (1,3,6,8 R.H. and 1,3,4,6,8 L.H.)	No. 10 Green
11	9	Michigan Markers - Front	No. 16 Black-Red Ch.
12	9	Michigan Markers - Rear	No. 16 Red-Bl. Tr.
13	20	Clearance Lights	No. 14 Black-Red Ch.
14	9	Front Emblem	No. 16 Black-Tan Tr.
		Destination Sign and Night Lights	No. 14 Black Tan Tr.
15	14	General Lighting (2,4,5,7 R.H. and 2,5,7,9 L.H.)	No. 12 Brown
16	14	General Lighting (1,3,6,8 R.H. and 1,3,4,6,8 L.H.)	No. 12 Blue
17	20	Indirect Lights (1,3,5,7,9,11,13 R. and L.)	No. 12 White
18	20	Indirect Lights (2,4,6,8,10,12 R. and L.)	No. 12 Brown-Bl. Red. Cr. Tr.
19	20	Defrosters - R. and L.	No. 14 Black-Gr. Ch.
20	9	Baggage Compartment Lights	No. 14 Green-Bl. Tr.
21	9	Step Lights	No. 16 Yellow - 2 Blue Tr.
22	20	Engine Stop	No. 14 Green
23	—	Feed From Dimmer Switch to #23 and #24 Buss Bar	No. 12 Yellow-Bl. Tr.
	9	L.H. Headlight Hi-Beam	No. 14 White-Bl. Cr. Tr.
		Headlight Hi-Beam Tell-Tale	No. 16 White-Black Tr.
24	9	R.H. Headlight Hi-Beam	No. 14 White-Bl. Tr.
25	—	Feed From Dimmer Switch to #25 and #26 Buss Bar	No. 12 Yellow
	9	L.H. Headlight Low Beam	No. 16 White-Green Cr. Tr.
26	9	L.H. Headlight Low Beam	No. 16 White-Green Cr. Tr.
27	14	Fresh Air Blower - R.H.	No. 14 Yellow
28	—	Feed to #27 and #28 Buss Bar	No. 12 White-Red Tr.
	14	Fresh Air Blower L.H.	No. 14 Red
29	—	Feed to #29 to #32 Buss Bar	No. 8 Red
	20	Horn Relay Feed	No. 10 Yellow
		Spot Light	No. 16 White
30	20	Driver's Light	No. 16 Blue-Yellow Tr.
31	14	Stop Light	No. 14 Green-Black Tr.
32	—	Emergency Stop Feed	No. 14 Brown-Red Tr.
		Directional Signals	No. 16 White-Green Cr. Tr.

WIRING AND MISC. ELEC.

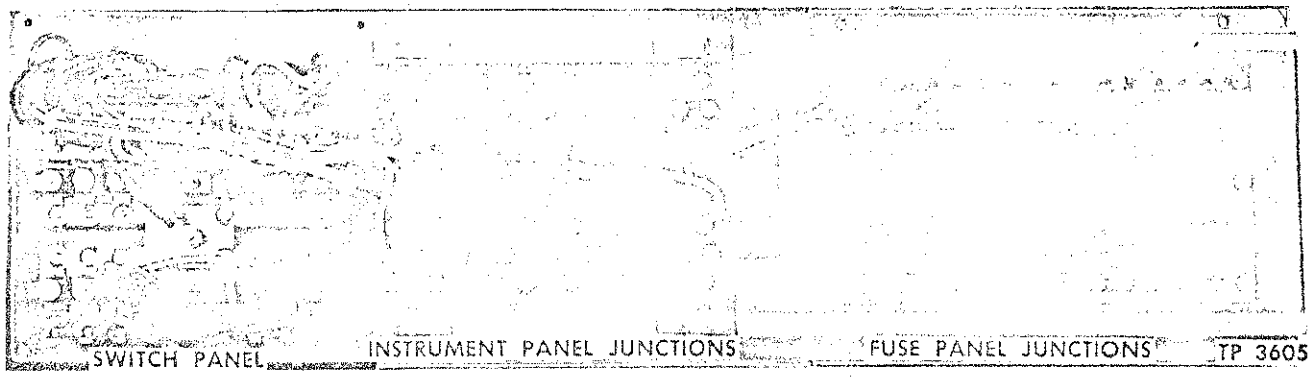


Figure 5—Rear View of Switch Panel, Fuse Panel, and Instrument Panel Junctions.

INSTRUMENT PANEL JUNCTIONS

Instrument panel junctions are located at front of vehicle behind a panel assembly. Refer to figure 5 for illustration of junctions.

The following tabulation lists terminal number, circuit and wire size and color. Refer also to wiring diagram (fig. 1) for circuit identification.

(See Triangular △ Symbol On Wiring Diagram)

Term No.	Circuit	Wire Size and Color
1	Moto-Gard	No. 14 Red-Black Tr.
2	Reverse Switch	No. 14 Blue
3	Starter Switch	No. 14 Red
4	Tell-Tale Alarm	No. 14 Brown-Black-Red Cr. Tr.
5	Charge Indicator	No. 14 Brown-Black Tr.
6	Water Overheat Thermostat	No. 16 Yellow
7	Water Temperature	No. 16 Blue-Yellow Tr.
8	Engine Emergency Stop	No. 14 Brown-Red Tr.
9	Low Oil Pressure	No. 16 White-Black & Gr. Cr. Tr.
10	Oil Pressure	No. 16 White - 2 Green Tr.
11	Directional Lights Tell-Tale	No. 16 White
12	Directional Light	No. 16 Green
13	Horn	No. 16 Black-White Tr.
14	Stop Lights	No. 16 Red
15	Stop Lights Switch	No. 14 Green-Black Tr.
16	Horn	No. 10 Brown-Bl. & Red Cr. Tr.
17	Low Air Pressure Switch	No. 16 Blue
18	Directional Lights - L.H.	No. 16 White-Black Cr. Tr.
19	Directional Lights - R.H.	No. 16 White-Red Cr. Tr.
20	Air Conditioning "Turn On" Tell-Tale	No. 16 Black-Yellow Cr.
21	Air Conditioning "Turn Off" Tell-Tale	No. 16 Brown-Black Tr.
22	Passenger Buzzer	No. 16 Brown-Black & Red Cr. Tr.
23	Emergency Door Switch	No. 16 Black-Red Tr.
24	Fresh Air Blower Magnetic Switch	No. 12 Red-White Tr.
25	Fresh Air Blower Cut-out Switch (Except N.Y. State)	No. 16 Green-Red Tr.
26	Moto-Gard and Tell-Tale Alarm Relay	No. 16 White - 2 Black Tr.
27	Tell-Tale Alarm Buzzer	No. 16 Yellow-Red Tr.
28	Stop Light Tell-Tale	No. 16 White-Red Tr.
29	Low Air Pressure Tell-Tale	No. 16 Black-Red Ch.
30	Ground	
31	Driver's Blower Switch	No. 12 White-Black Cr. Tr.
32	Air Conditioning Ignition	No. 14 Green-Black Tr.
33	Main Blower Magnetic Switch	No. 14 Green-White Tr.
34	Air Conditioning Engine Starter	No. 14 Black-Green Tr.
35	Air Conditioning Engine Starting Ignition	No. 14 Black-Tan Tr.
36	Air Conditioning "Stop Engine" Tell-Tale	No. 16 Black-Green Ch.
37	Stop Lights Relay	No. 14 Black-Red Tr.
38	Stop Lights in Target Sign	No. 16 Red-White Tr.
39	Charge Indicator	No. 14 White
40	Charge Indicator	No. 14 Green-Red Tr.

BODY JUNCTIONS

Body junction panel is located over the driver's window. Junction terminals are accessible by removing small panel at inside of body. Each terminal is numbered for easy identification.

The following tabulation and wiring diagram (fig. 1) will serve to identify each terminal, circuit and wire size and color.

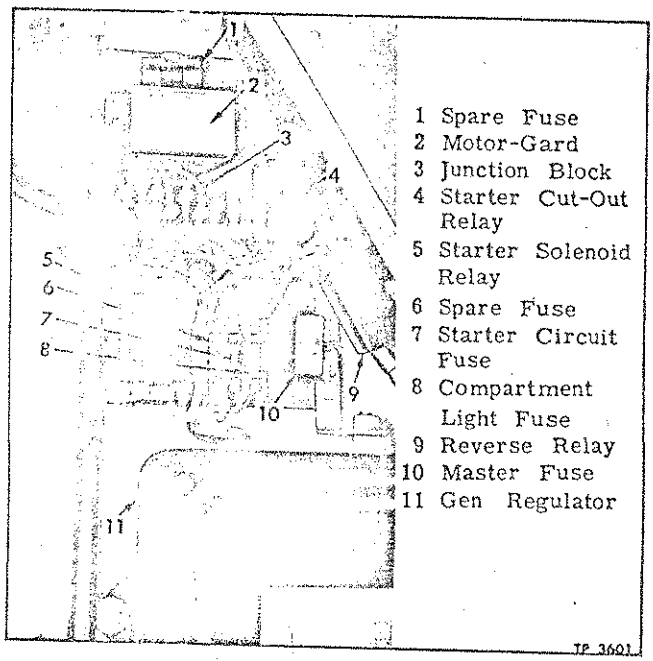
(See Hexagon ⬡ Symbol On Wiring Diagram)

Term No.	Circuit	Wire Size and Color
1	Destination Sign and Light Lights	No. 14 & 16 Black-Tan Tr.
2	Front Corner Marker Lights	No. 16 Green
3	Reading Lights (#1,3,6,8 R.H. & 1,3,4,6,8 L.H.)	No. 10 & 12 Green
4	General Lighting (#1,3,6,8 R.H. & 1,3,4,6,8 L.H.)	No. 14 Blue
5	Reading Lights (#2,4,5,7 R.H. & 2,5,7,9 L.H.)	No. 12 Red
6	General Lighting (#2,4,5,7 R.H. & 2,5,7,9 L.H.)	No. 14 Brown
7	Passenger Buzzer Switches	No. 16 Brown Bl. & Red Cr. Tr.
8	Michigan Markers - Rear	No. 16 Red-Black Tr.
9	Fresh Air Blower - R.H.	No. 14 Yellow
10	Rear Corner Marker Lights	No. 16 Black-Green Tr.
11	Fresh Air Blower - L.H.	No. 14 Red
12	Indirect Lights (#1,3,5,7,9,11,13 R. & L.)	No. 14 White
13	Emergency Door Switch	No. 16 Black-Red Tr.
14	Indirect Lights (#2,4,6,8,10,12 R. & L.)	No. 14 Brown-Bl. & Red Cr. Tr.

ENGINE COMPARTMENT PANEL

Engine compartment panel (fig. 6) is located at right rear corner of vehicle. Assembly consists of master fuse, starter circuit and engine compartment light fuses, starter solenoid and starter cut-out relays, spare master fuse and six post junction block. Assembly is accessible through a door at right rear corner of vehicle.

The following tabulation and wiring diagram (fig. 1) will serve to identify each terminal, circuit and wire size and color.



1 Spare Fuse
2 Motor-Gard
3 Junction Block
4 Starter Cut-Out Relay
5 Starter Solenoid Relay
6 Spare Fuse
7 Starter Circuit Fuse
8 Compartment Light Fuse
9 Reverse Relay
10 Master Fuse
11 Gen Regulator

Figure 6—Engine Compartment Panel

(See Square □ Symbol On Wiring Diagram)

WIRING AND MISC. ELEC.

ENGINE DISCONNECT PLUG

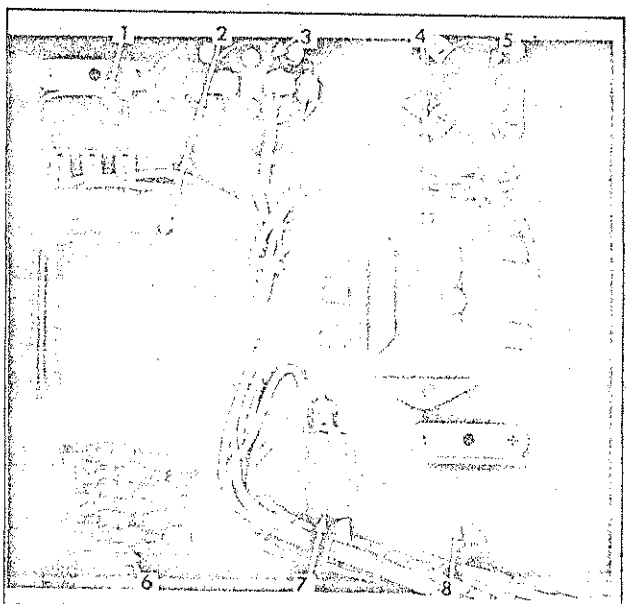
An engine disconnect plug is mounted on engine compartment panel at right side of vehicle. This plug provides a quick and easy means of disconnecting engine electrical units whenever engine is to be replaced.

The following tabulation and wiring diagram (fig. 1) will serve to identify each circuit and wire size and color.

(See Symbol X On Wiring Diagram)

BEFORE Chassis No. 101	AFTER Chassis No. 100	Circuit	Wire Size and Color
C	A	Oil Pressure Gauge	No. 16 White - 2 Green Tr.
H	B	Water Temperature Gauge	No. 16 Blue-Yellow Tr.
E	C	Water Overheat Thermostat	No. 16 Yellow
G	D	Generator Ground	No. 14 Black
I	E	Starter Solenoid	No. 10 Red
A	F	Generator Field	No. 14 Black-Red Ch.
F	G	Emergency Stop Solenoid	No. 14 Brown-Red Tr.
B	H	Engine Stop Solenoid	No. 14 Green
D	I	Oil Pressure Switch	No. 16 White-Black & Gr. Cr. Tr.

ELECTRIC HORN



1 Alarm Buzzer Relay
2 Passenger Buzzer
3 Fresh Air Blower Relay
4 Stop Light Relay
5 Moto-Gard and Tell Tale Alarm Relay
6 Air Conditioning Fuse Panel
7 Directional Signal Flasher
8 Horn Relay

Figure 7—Buzzer and Relay Panel Assembly

Horn (fig. 8) operates on magnetic principle to produce warning signal. Current from battery flows through windings within horn when circuit is completed at horn button (switch). Horn circuit is protected by a fuse. Refer to wiring diagram (fig. 1) in this section.

Before adjusting horn check following conditions which affect performance:

LOW HORN VOLTAGE

If horn produces a weak signal, voltage at horn should be checked. Connect a voltmeter across horn terminals. The voltage reading should not be less than 11 volts. A lower reading indicates either a low battery or a high resistance in horn circuit.

Loose or corroded connections in horn circuit should be corrected. Check for defective wiring by connecting separate test leads from horn to battery.

A loose connection or poor contact at horn push button may cause horn to operate intermittently. Shunt around horn button to determine whether there is poor contact at push button. Whenever wiring is replaced in horn circuit, use correct size, as shown on wiring diagram.

Horns usually have a rasping sound when vital parts are broken or loose. A loose back shell may affect tone. Tighten collar screws, mounting nuts, and studs. Replace all damaged parts.

The horn will not function properly if field windings within horn are open circuited, or grounded. Connect an ammeter in circuit at horn terminal. If there is no indication of current flowing when contact points are closed, windings are open circuited. The ammeter will indicate an excessive flow of current if windings are short circuited or grounded.

Windings may also be checked for grounded circuit with test lamp. Disconnect horn leads and touch one test point to one of horn terminals. If lamp lights, field windings are grounded.

Excessive arcing at contact points may be caused by improper current adjustment. An open circuit in condenser will cause excessive arcing at points and, in some cases, contacts will be held together.

HORN ADJUSTMENTS

If tone is not satisfactory after checking preceding conditions, adjust horn in following manner:

1. Remove shell from horn.
2. Connect ammeter in circuit at horn and adjust current consumption by varying position of adjusting nut. See "Specifications" at end of this section, for current consumption.
3. Loosen adjusting lock nut and turn adjusting nut to left or right to increase or decrease current.
4. Too much current will cause horn to have a spluttering sound. This adjustment is very sensitive. Move nut 1/10 turn at a time and lock in position each time before trying. If ammeter is not available, adjust according to sound.
5. Correct air gap between armature and core is important for proper tone. The gap must be uniform across entire surface of armature. Width of gap may be determined by using a feeler. Adjustments are made by use of air gap adjusting nuts. Refer to "Specifications" at end of this section for correct adjustment dimensions.

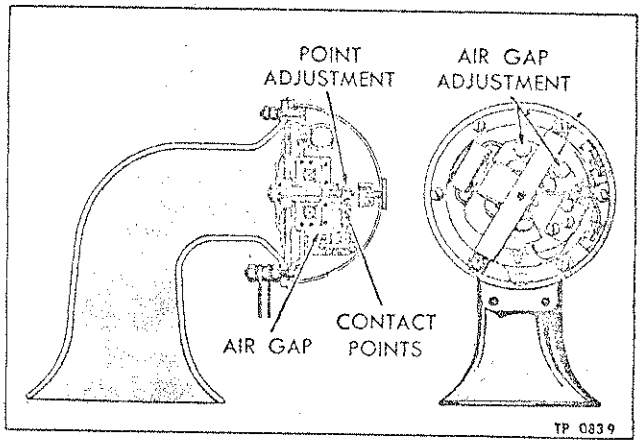


Figure 8—Electric Horn

HORN RELAY

Horn relay, illustrated sectionally in figure 9 is mounted on buzzer and relay panel assembly.

Relay is connected in such a manner that upon completion of circuit at horn button (switch) contact points are closed. Current is then fed directly from battery through contact points to horns, thus avoiding voltage drop through horn button circuit.

Maintenance and adjustment operations are given in following paragraphs. Removal of snap on cover will make relay mechanism available for adjustments.

Aid Gap Adjustment

With the contact points closed, measure the air gap between the armature and center of core. Adjust air gap by loosening two screws and move armature up or down as required (fig. 9). If necessary, align the support carrying the lower contact so that the air gap will be uniform between the core and the armature. Refer to "Specifications" at end of this section, for proper air gap.

Point Opening Adjustment

Measure the contact point opening with the armature in the open position. Adjust by bending armature stop (fig. 9). Refer to "Specifications" at end of this section, for correct point opening.

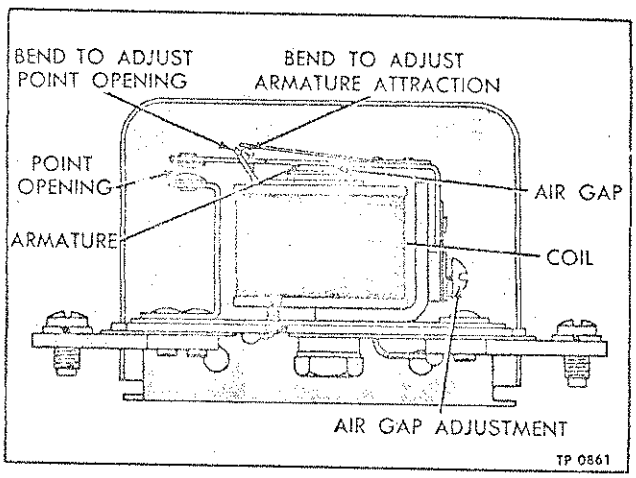


Figure 9—Horn Relay

Voltage Adjustment

Connect an accurate voltmeter across the "S" and "B" terminals, then connect a variable resistance from "S" terminal to ground. Adjust resistance, noting voltmeter reading at which points close. Reading should be same as listed in "Specifications" at end of this section.

Adjust, if necessary, by bending armature spring stop as required to obtain correct settings.

ALARM SYSTEM

An elaborate alarm system is used to warn the operator of four conditions requiring immediate attention. These four conditions are (1) Low Air Pressure (2) Emergency Door Not Closed (3) Low Oil Pressure (4) Water Overheated.

Whenever the air pressure is low or the emergency door is open an electrical circuit is completed through a tell-tale alarm relay which causes the buzzer to sound and one of the tell-tale lights to illuminate. If the buzzer sounds note

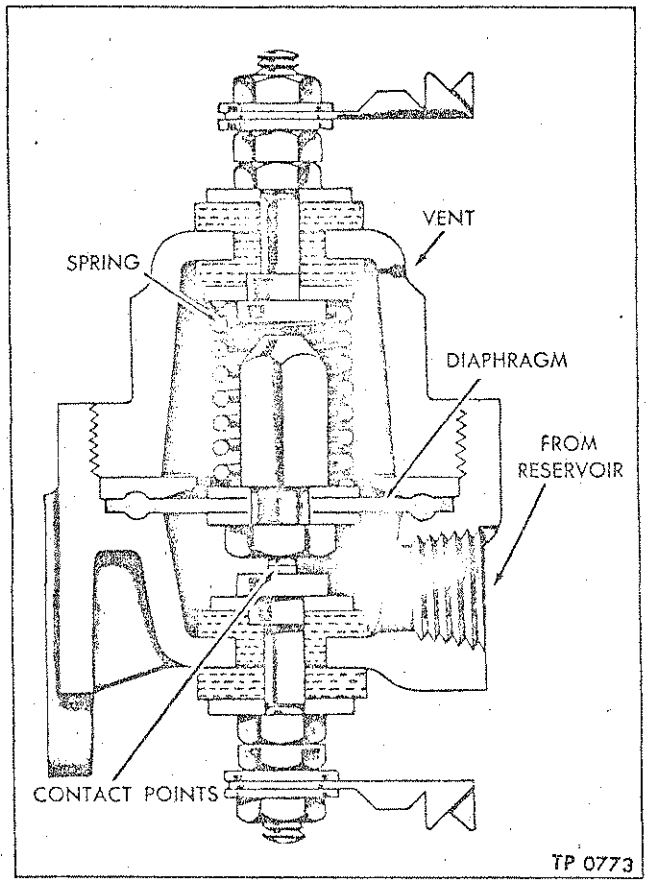


Figure 10—Low Air Pressure Indicator

which of the tell-tale lights is illuminated and take the necessary action to correct the condition.

If the oil pressure becomes dangerously low or water becomes overheated the buzzer sounds and tell-tale lights are illuminated. In addition, an electrical circuit is completed which causes emergency stop solenoid to operate and stop engine, except when transmission is in 1st speed.

Operation of the alarm system as it applies to the driver is explained under "Moto-Gard and Tell-Tale Alarm System" in Operation Sec. O, of this manual).

LOW AIR PRESSURE INDICATOR

The low air pressure indicator (fig. 10) is a safety device designed to automatically give a visual and audible warning when the air pressure in the air system falls below a safe limit for brake operation. The low pressure indicator is actually an air controlled switch in an electrical circuit, automatically controlling a tell-tale light on the gauge panel and a buzzer on the relay panel. Low pressure indicator is connected in air lines as shown in air lines diagram in "Brakes" (Sec. 4B of this manual).

OPERATION

The low pressure indicator shown in figure 10 is in cut-in position, that is, the pressure in the air brake system is below the specified limit (54 to 66 lbs.) and the contact points are closed, causing the tell-tale light to illuminate. When air pressure is built up in air brake system, which is connected to cavity under diaphragm, pressure under diaphragm overcomes spring tension above diaphragm, lifting the upper contact point off the lower contact point, breaking the electrical circuit to the tell-tale light.

The electrical circuit is connected through the engine control switch so that the tell-tale light will illuminate only when the control switch is in "Run" position. When the vehicle has been standing for a long period with the engine stopped and the air pressure is low, the tell-tale light will come on automatically when the control switch is turned on and will stay on until the pressure in the air brake system is built up to the specified limit. When operating vehicle on road and tell-tale light comes on, stop vehicle immediately and determine the cause of pressure loss.

SERVICEABILITY TESTS

1. Operating Tests

a. With no air pressure in system, turn control switch on and start engine. The low pressure tell-tale light must remain on until the pressure in the air brake system reaches a point between 54 and 66 pounds, at which point the tell-tale light must go out.

b. Continue to build up pressure in system to at least 75 pounds, then stop engine. Reduce the pressure in the air brake system by making brake application and note pressure when tell-tale light comes on. The light should come on when the pressure is lowered to a point between 66 and 54 pounds.

2. Leakage Test

With the air brake system fully charged, coat the outside of the low pressure indicator with soap suds to check for leakage. No leakage is permissible. Leakage at the lower terminal can sometimes be corrected by removing the electrical connection and carefully tightening the terminal nuts. Leakage through the small vent hole near the top of the unit signifies a leaking diaphragm. This condition requires replacing the diaphragm.

REPLACEMENT

1. Removal

Exhaust air pressure from system. Disconnect air line and electrical connections. Remove mounting bolts and remove unit from vehicle.

2. Installation

Position unit and install mounting bolts. Connect air lines and electrical connections. Build up air pressure in system and test unit as previously directed under "Serviceability Tests."

DISASSEMBLY

1. Unscrew top cover from body of unit. Remove spring, diaphragm washer, and diaphragm assembly.

2. Disassemble diaphragm assembly by removing nut from diaphragm screw and removing diaphragm and two washers from screw.

3. Remove terminals from cover or body by removing terminal nuts, flat washer, and fibre washer from terminals, then remove terminal with flat washer and fibre bushing from inside of cover or body.

INSPECTION AND REPAIR

1. Clean all metal parts thoroughly, using a suitable cleaning fluid.

2. Inspect diaphragm for signs of wear or cracking. Install new diaphragm if these conditions exists.

3. Inspect contact points for pitting or corrosion. If points are only slightly pitted or corroded, they can be repaired by carefully filing with a fine distributor point file. If points are badly pitted or corroded, the diaphragm screw and lower terminal, complete with new points, must be replaced with new parts.

ASSEMBLY

1. Select lower terminal (with contact point) and install flat washer with D-shaped hole in washer over D-shaped shoulder on head of terminal. Install fibre bushing on terminal, with D-shaped hole over shoulder on terminal and large side of bushing next to flat washer. Install the terminal, washer, and bushing in body with square shoulder of bushing in square hole in body. Install the following parts on the terminal in the order named: Rubber seal washer, fibre washer, flat washer, and two terminal nuts. Tighten nuts firmly.

2. Select upper terminal (without contact point) and install flat washer and fibre bushing on terminal head. Install terminal with washer and bushing in cover, with square shoulder on bushing in square hole in cover. Install fibre washer, flat washer, and two nuts on terminal and tighten nuts firmly.

3. To assemble diaphragm, place beveled washer on diaphragm screw with flat side of washer next to shoulder on screw. Install diaphragm on screw, then install another beveled washer with beveled side against diaphragm. Install nut on diaphragm screw and tighten only enough to form an air-tight seal, then stake nut in place. Excessively tightening nut will distort diaphragm.

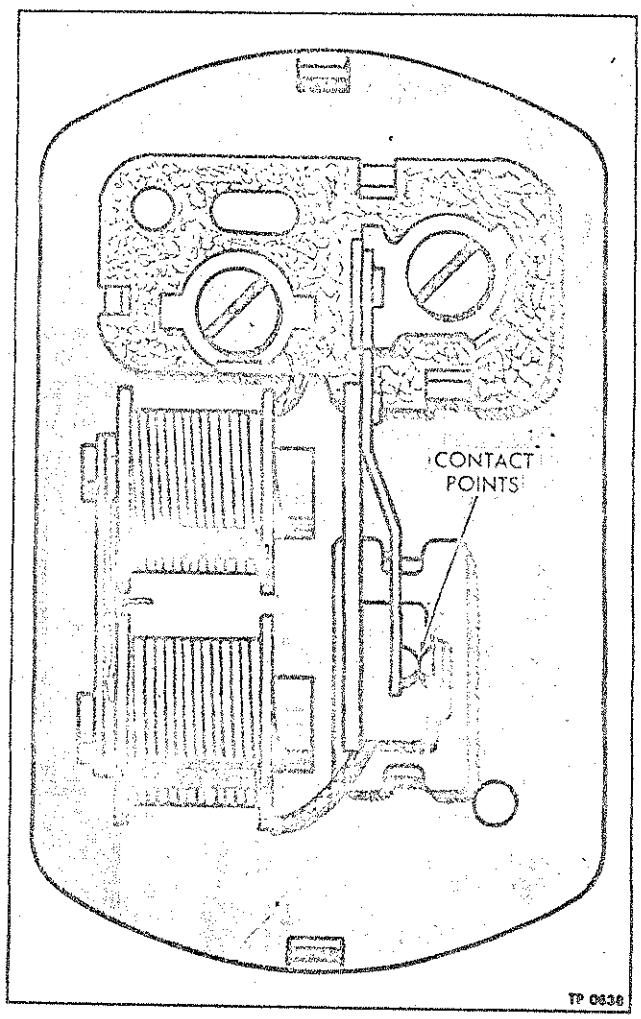


Figure 11—Tell-Tale Alarm Buzzer

4. Place diaphragm assembly in body and press down on edges of diaphragm with fingers to seat ridge on bottom of diaphragm in groove in body. Install diaphragm washer in body with beveled and grooved side next to diaphragm. Press washer firmly down to make sure the groove in washer is seated over ridge on top of diaphragm.

5. Place spring over diaphragm screw and install cover over spring. Compress spring and screw cover into body. After tightening cover, look through air inlet port to see that contact points are in proper alignment.

TELL-TALE ALARM BUZZER

Tell-tale alarm buzzer (fig. 11) is mounted on relay and buzzer panel (fig. 7) at rear of gang switch panel. Alarm buzzer warns the driver audibly of four conditions as follows (1) Low Air Pressure (2) Emergency Door Not Closed (3) Low Oil Pressure (4) Water Overheated. Buzzer is

WIRING AND MISC. ELEC.

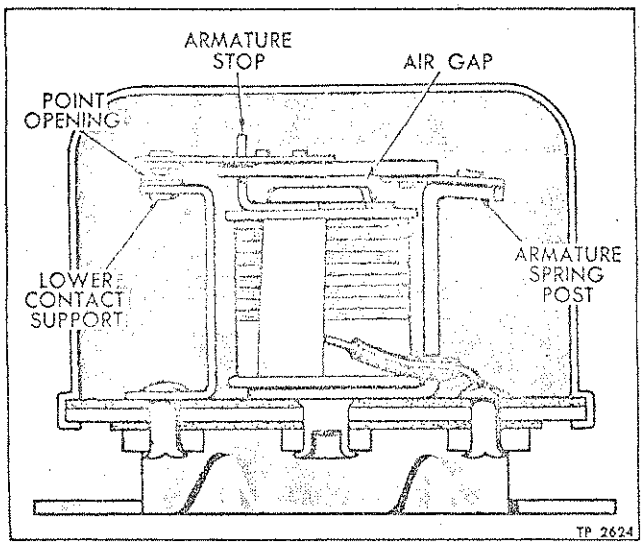


Figure 12—Tell-Tale Alarm Buzzer Relay

operated by the tell-tale alarm buzzer relay when condition 1 or 2 exists and through Moto-Gard tell-tale alarm relay when condition 3 or 4 exists. Refer to wiring diagram (fig. 1) for circuit, wire size and color and terminal junctions.

MAINTENANCE

Contact points of buzzer should be inspected periodically and cleaned when necessary. Remove cover of buzzer for access to points.

As a safety precaution, emergency door buzzer should be tested daily. Make sure engine control switch is turned on. Release emergency door latch; buzzer should sound. If buzzer does not sound, proceed as follows:

Test

1. If buzzer fails to operate, first make sure that No. 3 instrument panel fuse is not blown. Remove buzzer cover and make sure contact points are clean and in contact, and that terminal screws are tight. If buzzer still fails to operate, check circuit continuity in following sequence, using voltmeter or test light having a 12 volt, 1.5 candlepower bulb.

2. Turn engine control switch on. With one test lead grounded, touch other lead to both buzzer terminals. If no current is obtained at either terminal, defective wiring between instrument panel and buzzer is indicated.

3. Current should be obtained from one terminal of buzzer. With a jumper wire, ground the dead terminal - buzzer should sound.

4. If buzzer does not operate, remove buzzer for repair or replacement.

5. To test circuit (except buzzer), remove leads from buzzer and attach each lead to voltmeter or test light lead. If current indication is obtained when emergency door is unlatched, circuit (except buzzer) is operating properly.

6. If current indication is not obtained, switch and wiring should be carefully checked for open circuits.

TELL-TALE ALARM BUZZER RELAY

Tell-tale alarm buzzer relay (fig. 12) is used to complete low air pressure switch and emergency door switch electrical circuit to tell-tale alarm buzzer. Whenever either of these switches are closed an electrical circuit is completed through the relay which causes the buzzer to sound and warn the driver that one of these conditions exists. Relay is mounted on a buzzer relay panel (fig. 7) located behind gang switch panel. Refer to wiring diagram (fig. 1) for circuit, wire size and color and terminal junctions.

ADJUSTMENT

Refer to "Specifications" later in this section for air gap and point opening dimensions, and for closing voltage.

Air Gap

Disconnect lead from terminal "B." Check air gap between armature and core with contact points in closed position. Adjust by bending lower contact support (fig. 12). Align lower contact support so that air gap between core and armature will be uniform.

Contact Point Opening

Check contact point opening and adjust, if necessary, by bending armature stop (fig. 12). Clean contact points with a thin fine-cut contact file if pitted.

Closing Voltage

Connect lead of an accurate reading voltmeter to terminal "S" and other lead to terminal "B."

To check closing voltage with relay on vehicle, it will be necessary to insert a variable resistance of 10 ohms (capable of carrying 1 ampere) in series at "B" terminal on relay.

With horn button depressed, adjust variable resistance until relay points close and note reading on voltmeter. Adjust by bending armature spring post to increase or decrease tension on armature. Increasing tension increases closing voltage.

LOW OIL PRESSURE SWITCH

Low oil pressure switch is an electrical unit installed in the engine oiling system at a point where oil pressure exists. When engine is running the oil pressure acts upon a diaphragm to hold a pair of switch contacts open. However, if the

pressure should drop to between 2 and 4 lbs. pressure the points will close, thereby completing an electrical circuit.

Closing the points causes the tell-tale light to illuminate, Moto-Gard tell-tale alarm relay functions to cause alarm buzzer to sound, relay also permits current ot flow to a ground in the Moto-Gard. As current reaches the Moto-Gard a bi-metal element is heated causing contact points to close and current to flow to a special drum (rotary) switch. Switch is connected to transmission controls in such a manner that current reaches emergency stop solenoid, except when transmission is in 1st speed. Current reaching emergency stop solenoid immediately operates solenoid to close air choke valve and stop engine.

Refer to wiring diagram (fig. 1) for electrical circuits, terminals, wire sizes and colors.

Circuit Test

Circuit is connected to generator armature and therefore is not energized until generator is at charging speed.

With generator operating at charging speed, momentarily short the two wire terminals at engine pressure switch and note if tell-tale light is illuminated. If light is illuminated and buzzer sounds, the wiring, bulb, relay and buzzer are operating satisfactorily.

Failure of tell-tale to light or buzzer to sound inidcates that the circuit common to one or both of these units is at fault. Refer to wiring diagram (fig. 1) for circuit terminals.

WATER OVERHEAT THERMOSTAT

Water overheat thermostat is an electrical unit installed in the engine water manifold. When the water temperature becomes excessive an electrical circuit is completed. Completing the circuit causes a tell-tale light to illuminate, Moto-Gard tell-tale alarm relay functions to cause alarm buzzer to sound, relay also permits current to flow to a ground in Moto-Gard. As current reaches the Moto-Gard a bi-metal element is heated causing contact points to close and current to flow to a special drum (rotary) switch. Switch is connected to transmission controls in such a manner so that current reaches emergency stop solenoid except when transmission is in 1st speed. Current reaching the emergency stop solenoid immediately operates the solenoid to close the air choke valve and stop the engine. Refer to wiring diagram (fig. 1) for electrical circuit, terminals, wire size and colors.

Circuit Test

Circuit is connected to generator armature and therefore is not energized until generator is at charging speed.

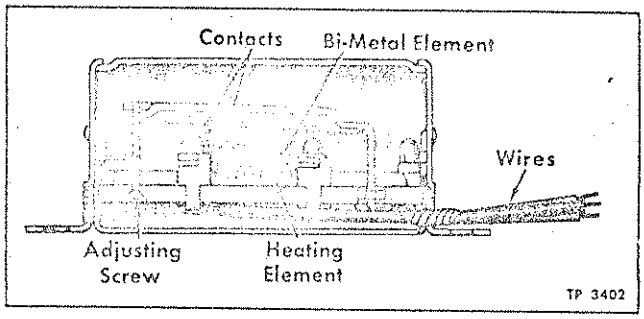


Figure 13—Moto-Gard

With generator operating at charging speed, momentarily short the wire at thermostat terminal and note if tell-tale light is illuminated. If light is illuminated and buzzer sounds, the wiring, bulb, relay and buzzer are operating satisfactorily.

Failure of tell-tale to light or buzzer to sound indicates that the circuit common to one or both of these units is at fault. Refer to wiring diagram (fig. 1) for circuit terminals.

MAINTENANCE

At 15,000 miles intervals remove thermostat cylindrical cover, clean contact points, if necessary, and blow out any dirt in the interior of the body.

At 30,000 mile intervals, the thermostat should be removed and tested for actual operation. This can easily be done by inserting tube of thermostat in oil heated to a temperature of 250 to 275 degrees F. If the points contact readily, correct working of the instrument is indicated. (The 250 to 275 degrees F. temperature for the testing oil is arbitrarily selected in order to make the check quickly and bears no relation to the temperature at which the thermostat is set.)

> NOTE: Before testing thermostat be sure that entire unit is pre-heated to approximately engine temperature (170 degrees F).

At any time excessive engine temperature causes the instrument to act, the thermostat should be removed from the vehicle and checked as above.

MOTO-GARD

Moto-Gard (fig. 13) is mounted on engine compartment panel (fig. 7) and is connected into wiring circuit as shown in wiring diagram (fig. 1).

The purpose of the Moto-Gard is to assist in completing an electrical circuit to emergency stop solenoid whenever oil pressure is low or

WIRING AND MISC. ELEC.

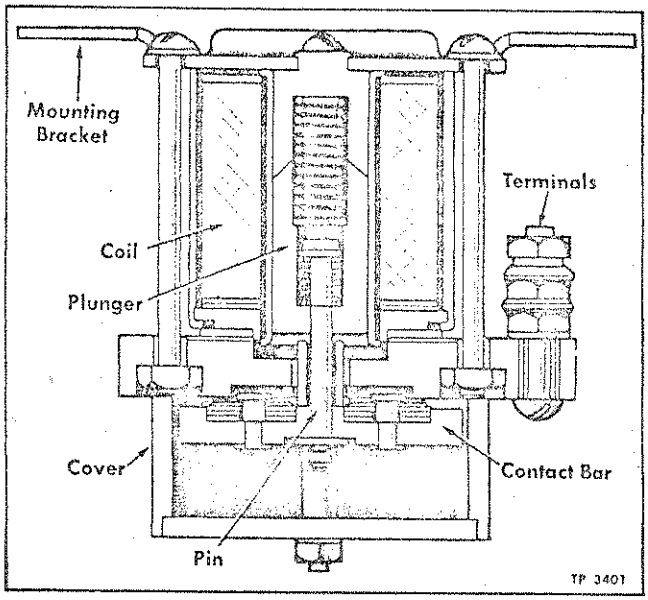


Figure 14—Moto-Gard and Tell-Tale Alarm Relay

water in engine is too hot. The action of the Moto-Gard is not immediate, as the bi-metal unit within the Moto-Gard must become heated before contact points close to complete the circuit. This requires approximately 20 seconds.

Test

Moto-Gard and wiring should be checked at approximately 5,000 mile intervals. To test, ground the wire from the low oil pressure switch or water overheat thermostat and at the same time accelerate the engine to a point where the generator is charging. The tell-tale light should illuminate immediately and the emergency stop solenoid should trip in less than 60 seconds. If the solenoid fails to operate check the wiring and test the solenoid. Do not ground the Moto-Gard for more than 1 minute at a time as it may be seriously damaged.

If the solenoid and wiring tests are satisfactory yet the Moto-Gard fails to stop the engine it should be replaced with a unit known to be operating satisfactorily.

DRUM SWITCH

A drum or rotary switch, installed in right side of engine compartment, is connected to transmission first speed lever. Purpose of switch is to permit vehicle operation in transmission first speed only, whenever the Moto-Gard circuit is energized by action of low oil pressure switch or water overheat thermostat.

Refer to Operation (Sec. O of this manual) also to wiring diagram (fig. 1) for electrical circuit.

Switch Maintenance

Switch contacts and terminals are enclosed within the switch body and should be cleaned at periodic intervals. Access to contacts is through a body cover held in place by a snap spring. Disconnect linkage and rotate switch. Use fine abrasive cloth to clean contact spring and drum. Clean terminals of accumulated corrosion or foreign matter. Reconnect linkage and install body cover.

SWITCH LINKAGE ADJUSTMENT

At time of installation the switch control linkage is properly adjusted and ordinarily should not require further attention, however an adjustment may sometimes be necessary. Remove clevis pin at switch lever. Place transmission in first speed. Remove cover from switch. Loosen yoke lock nut and turn yoke until clevis pin hole in yoke and switch lever are in alignment while switch is in neutral or no contact position. Install clevis pin and tighten yoke lock nut. Install switch cover and shift transmission into neutral.

MOTO-GARD AND TELL-TALE ALARM RELAY

Relay (fig. 14) is mounted on buzzer and relay panel (fig. 7). Purpose of this relay is to energize the alarm buzzer and Moto-Gard circuits whenever either the low oil pressure switch or water overheat thermostat contact points close to complete the circuit. Current for operation of the relay is supplied from generator armature and is therefore operative while generator is charging.

Refer to wiring diagram (fig. 1) for circuit and terminal identification.

INSPECTION AND CLEANING

Remove cover to inspect points. Points are silver and tend to oxidize (blacken), which does not impair efficiency. Clean points only if pitted or burned, and not if merely blackened. Caution: Do not use file or emery paper on points. Use only fine crocus cloth or preferably toilet tissue, and with very light pressure.

POINT REPLACEMENT

If points are badly burned, replace contact bar. Remove split pin, washer and contact bar from plunger pin. Install new contact bar on plunger pin, then install washer and split pin. Test points for proper operation, then install cover.

TELL-TALE LIGHTS AND RESISTORS

Tell-tale lights are employed to signal the operator of various conditions, some of which

demand immediate attention. Some of these lights have a resistance unit connected in the circuit to insure operation under all conditions.

Refer to gauge panel (fig. 3) for location and identification of tell-tale and resistors, also to wiring diagram (fig. 1) for individual circuits.

ELECTRICAL SPEEDOMETER

The electric speedometer consists of a transmitter, head and connecting electrical wires.

The transmitter is mounted on and driven by the transmission. As the transmission rotates the transmitter rotor a three-phase alternating current is induced and transmitted to the head through the wiring. The frequency of this current varies with the speed of the transmission, thus the speed of the rotor in the head is precisely that of the transmitter rotor.

Rotation of the head rotor is transmitted to the speedometer dial pointer to visually record the speed of vehicle in miles per hour.

Testing

If a system becomes inoperative or is not operating properly the following checks should be made.

1. Check the continuity of external wires from plug to plug for possible open circuits or shorts.
2. Check the electrical resistance between any two terminals of transmitter. Resistance between terminals should be between 13-1/2 - 16-1/2 ohms.
3. Check electrical resistance between any two terminals of head. Resistance between terminals should be between 25-1/2 - 31-1/2 ohms.
4. Failure to obtain specified resistance values indicates that unit is damaged internally and should be replaced.

SPECIFICATIONS

Fuses

Master (Eng. Comp. Panel) (Amp's.)	150
Starter Circuit (Engine Comp. Panel) (Amp's.)	20
Engine Compartment Lights (Eng. Comp. Panel) (Amp's.)	20
Air Conditioning Blowers (Buzzer Panel) (Amp's.)	20
Miscellaneous (Fuse Panel)	Refer to "Fuse Panel" Tabulation in this Section also to Wiring Diagram.

Resistors

Low Air Tell-Tale	5 Ohms
Emergency Door Tell-Tale	5 Ohms
Low Oil Tell-Tale	6 Ohms
Water Overheat Tell-Tale	6 Ohms
Oil & Water Temperature Gauges	6 Ohms
Low Oil & Water Overheat	10 Ohms

Horn

Make	Delco-Remy
Model	1999700
Voltage	12
Air Gap	0.030" – 0.034"
Current	3.5 - 5.5
Frequency	300 - 320

Horn Relay

Make	Delco-Remy
Model	1116818
Air Gap (Points Closed)	0.020"
Point Opening	0.030"
Armature Attracted (Volts)	6.0 - 8.0

Low Air Pressure Indicator

Make	Bendix-Westinghouse
Model	076218
Contacts Close (Lbs.)	54 - 66

WIRING AND MISC. ELEC.

SPECIFICATIONS (Cont'd)

Tell-Tale Alarm Buzzer Relay

Make	Delco-Remy
Model	1116775
Air Gap (Points Closed)	0.015"
Point Opening	0.025"
Armature Attracted (Volts)	2.75 - 4.0

Low Oil Pressure Switch

Make	AC
Model	1506714
Contacts Break (Lbs. Pressure)	2 - 4

Water Overheat Thermostat

Make	Kysor
Model	Z-2373
Temperature Setting	212°F.

Moto-Gard

Make	Moto-Gard
Model	12-D

Moto-Gard Cut-Out Switch

Make	Nat'l. Pneumatic
Model	C-19720

Moto-Gard and Tell-Tale Alarm Relay

Make	Cutler-Hammer
Model	6041-H-47
Type	Single Throw Double Pole
Amperage	50
Voltage	12
Coil Data	
Resistance (Ohms)	16.0
Current (Amps)	.75
Pick-up & Close (Volts)	10
Drop Out & Open (Volts)	4.5

Electric Speedometer

Make	Eclipse-Pioneer
Model	
Transmitter	2276-1-A
Head	2232-12A-A

Battery

Contents of This Section

Related Subjects in Other Sections

The battery is an electro-chemical device for storing electrical energy, and when properly used, has two major functions. The first function is to govern, directly, the voltage of vehicle's electrical system. The second function is to provide electrical energy to starter while engine is being started. The battery also supplies energy, under limited conditions, to lights and other accessories.

The battery consists of six cells connected in series, giving a terminal voltage of twelve volts. Each cell is made up of an acid-proof compartment in which two groups of plates, positive and negative, are immersed in electrolyte, a solution of sulphuric acid and water.

The battery delivers energy when it is connected to an electrical circuit. This energy is derived from chemical reaction of sulphuric acid in the electrolyte and active materials in plates. During course of energy-producing reactions, sulphuric acid is absorbed and water produced, thus decreasing specific gravity of electrolyte.

After reaction between plates and electrolyte has continued for a considerable length of time, amount of available acid is so small as to prevent further delivery of useful energy, and battery is said to be discharged.

The generator is designed to restore to battery, energy consumed in starting, and then to assume burden of supplying complete electrical load. If generator fails in its duty and battery becomes run-down, charging from an outside source is necessary.

MAINTENANCE

Batteries are located in a battery compartment on left hand side of vehicle. Accessibility is through a door in body side panel.

Battery should be inspected and checked at least once a week. Inspection should include battery hold-down clamps, terminals, and electrolyte level. Each cell should be checked with an accurate hydrometer.

Battery terminals should be checked at periodic intervals. Remove all corrosion deposits, using a solution of ammonia in water. Coat terminals with petrolatum before tightening. Check battery ground strap and cable to starter, and replace when necessary.

Add pure (preferably distilled) water to each cell until water level is approximately 3/8 inch above plates. Do not overfill cells. Water should be added just before a run because unmixed water may freeze in cold weather.

Test each cell with an accurate hydrometer for specific gravity. The specific gravity indicates state of battery charge. The reading on fully-charged battery should be between 1.275 and 1.300. When reading is below 1.225 battery should be removed and recharged.

Freezing point of electrolyte depends on its specific gravity and condition of battery charge. Following table gives freezing temperatures of battery solution at various specific gravities:

Specific Gravity	Freeze Temp. Deg. F.	Specific Gravity	Freeze Temp. Deg. F.
1.100	+18	1.220	-31
1.120	+14	1.240	-51
1.140	+ 8	1.260	-75
1.160	+ 2	1.280	-92
1.180	- 6	1.300	-95
1.200	-17		

BATTERY

TESTING

Test each cell with an accurate hydrometer for specific gravity. The specific gravity indicates state of battery charge. The reading on a fully-charged battery should be between 1.275 and 1.300 at 60°F. When reading is below 1.225 battery should be recharged.

Battery may be tested with conventional testing instruments. These instruments, if used as manufacturer directs, will indicate conditions of battery prior to recharging or repairing.

Battery should be recharged with standard equipment. Do not bring an open flame near battery during charging, as explosive gases form in cells during this operation.

Testing cell voltage in connection with specific gravity test will give a good indication of battery condition. Battery must test higher than 1.240 and battery, engine, and starter must be at normal room temperature, otherwise test will not be accurate.

Operate starter and quickly check each cell of battery with low reading voltmeter. To prevent engine starting, hold stop switch button in. If voltage reading is less than 1.7 volts at 80°F, or if there is a difference between cell readings of more than 0.1 volt, battery trouble is indicated and battery should be removed for further check.

BATTERY CABLES

Check cable leads and connections to determine if they are in good condition. Excessive resistance, generally caused by poor connections, produces abnormal voltage drop which may lower voltage at starting motor to such a low value that normal operation of starting motor will not be obtained. Abnormal voltage drop can be detected with a low reading voltmeter as follows:

1. Check voltage drop between grounded battery terminal (positive) and vehicle frame. Place one prod of voltmeter on battery terminal and other on vehicle frame. With starting motor cranking engine at normal room temperature (70°F) voltage reading should be less than 0.3 volt. If more than this, there is excessive resistance in this circuit.

2. Check voltage drop between ungrounded battery terminal (negative) and starting motor terminal stud while motor is operated. If reading is more than one volt, there is excessive resistance in circuit.

NOTE: If necessary to extend wire from meter for this test, use No. 16 or larger wire.

3. Check voltage drop between starting motor housing and vehicle frame. This must be less than 0.1 volt.

CAUTION: When working on engine, precautions should be taken to prevent accidental starting of engine. Make certain that starter circuit cut-out switch is "OFF."

SPECIFICATIONS

Make	Exide
Model	6LXWG-17-3R
Voltage	12
Plates Per Cell	17
Ampere Hour (Each Battery)	126 @ 6 Hr. Rate
Quantity	Two, Connected in Parallel
Specific Gravity - Fully Charged	1.275 - 1.300
Recharged @	1.225

Starting System

Contents of This Section

Related Subjects in Other Sections

This section includes service information on units used in the starting system of models covered by this manual. The starters are identified by model numbers stamped on a plate attached to starter housing. Solenoids and relays are identified by a number stamped in the mounting bracket. Refer to "Specifications" later in this section for service data and model application.

The starting system includes battery, starter, solenoid, starter relay, starter control relay, starter buttons, cut-out switch, fuses and wiring.

Source of energy for operation of starting system is the battery, which is described in "Battery," (Sec. 7B of this manual).

Starting system is protected by two fuses, one of which is located behind instrument panel and the other on engine compartment panel.

Starting system circuits are shown on wiring diagrams in Wiring (Sec. 7A of this manual).

OPERATION AND CONTROLS

The starting system operation is dependent upon the function of each unit included in the system. Method of operating controls is fully described in "Operation" (Sec. O of this manual).

STARTER SOLENOID

Starter solenoid is used to shift starting motor pinion into mesh with flywheel ring gear and close the starting motor circuit causing motor to crank engine. Pressing starter button operates relays to complete starting motor circuit and energize solenoid. Solenoid is mounted on starting motor frame and plunger is connected by linkage to pinion shift lever. When solenoid is energized plunger pulls pinion into mesh with flywheel ring gear teeth. Plunger movement then continues, closing switch contacts and completing starting motor circuit. Starting motor then cranks engine.

Solenoid has two coils. The pulling coil draws comparatively heavy current for a short interval. This is needed to engage the pinion. The holding coil also aids the pulling coil. As soon as solenoid plunger completes starting motor circuit, pulling coil is de-energized by action of contact points and only holding coil draws current.

STARTER SOLENOID RELAY

Starter solenoid relay is used in conjunction with starter solenoid to magnetically shift starting motor pinion into mesh with flywheel ring gear and close the starting motor circuit. Pressing starter button closes relay circuit and energizes relay coil to close the contact points. This completes the solenoid circuit, solenoid magnetically shifts starting motor pinion and at the same time closes starting motor circuit causing motor to crank engine.

STARTER CUT-OUT RELAY

A starter cut-out relay is used in circuit between generator and starter solenoid relay. When generator is charging, relay coil is energized and contact points of relay are opened. This breaks starter relay circuit which is grounded through the starter cut-out relay and makes it impossible to close starter solenoid circuit and shift starting motor pinion to engage flywheel ring gear while engine is running.

STARTER CUT-OUT SWITCH

Switch is located on engine compartment control box panel and is used as a safety device to prevent accidental starting of engine while

STARTING SYSTEM

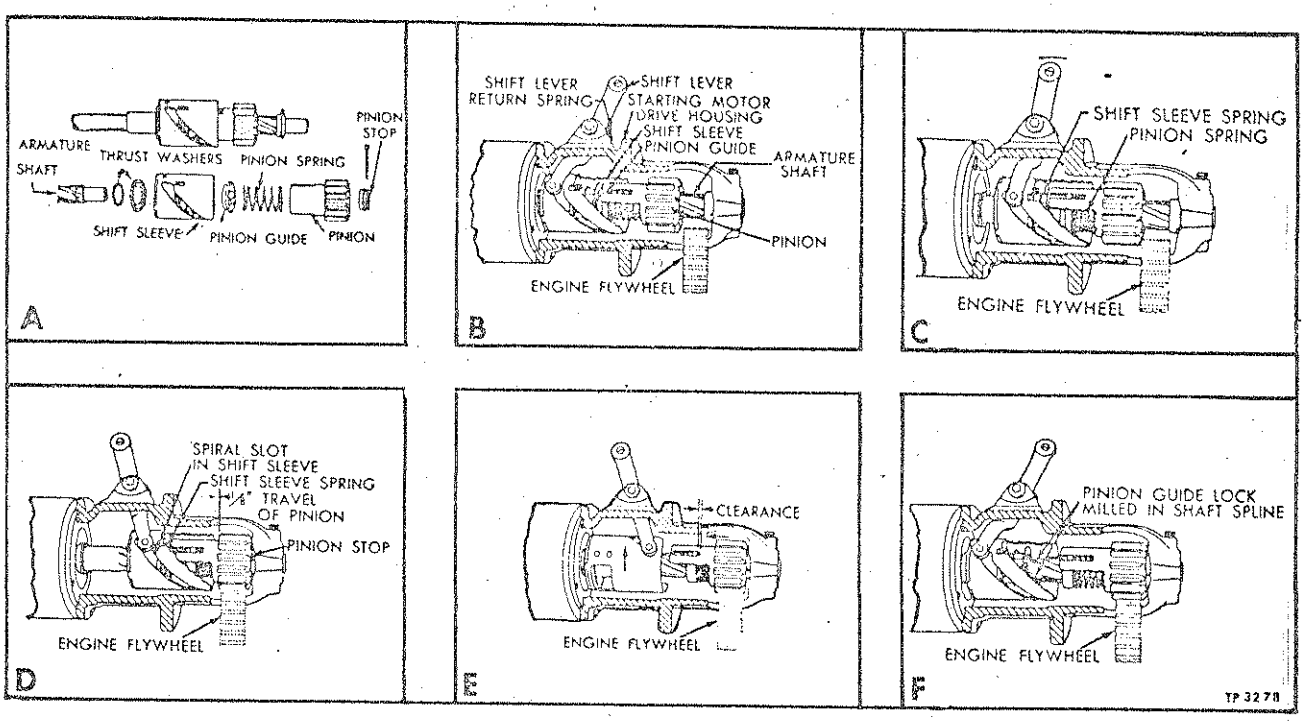


Figure 1—Dyer Drive Operating Positions

mechanic is servicing power plant. ALWAYS TURN SWITCH TO "OFF" POSITION WHEN SERVICING ENGINE.

STARTER SWITCH BUTTON

Two switches are used, one at instrument panel and other in engine compartment. These switches are inoperative while starter cut-out switch in engine compartment is "off" or when generator is charging so that starter control relay cuts out starting motor circuit.

STARTER DRIVE MECHANISM

The pinion meshes with flywheel by means of solenoid operated sleeve as previously described. The shift lever on starter is connected by linkage to solenoid. Return spring is used to hold shift lever in released position when not in use.

The detailed action of drive can be followed by referring to figure 1 and accompanying explanation. Each illustration represents a position or step through which drive assembly passes in a complete cranking operation. The drive housing, shift sleeve, and pinion are cut away showing action of parts. The engine flywheel is shown so that relative action of drive with flywheel can be noted.

At Rest Position (B, Fig. 1)

In the "At Rest" position, pinion is held away from flywheel by locking action of pinion guide and pinion spring in milled portion of the shaft spline. Refer to F, figure 1. The engine may, or may not, be in operation when drive is in this position. It is impossible for pinion to drift into flywheel when it is in this locked position.

Beginning of Engagement (C, Fig. 1)

The engine is "dead" and cranking operation has begun. As shift lever moves shift sleeve towards flywheel, pinion guide is unlocked from milled portion of spline by pressure of inner sleeve on guide. This action allows pinion to reach flywheel. If relative position of flywheel and pinion is such that teeth match, meshing will take place immediately. If teeth butt engagement, pinion is further rotated in its movement towards flywheel until it reaches position for meshing. Compression of inner coil spring against pinion guide compensates for continued movement of shift lever and shift sleeve.

Engagement Action Complete (D, Fig. 1)

When pinion has been rotated to proper position for engagement, action is completed by further movement of shift lever and action of pinion spring. The pinion stop limits travel of pinion. When meshing of pinion with flywheel is completed, further movement of shift lever closes starting motor switch contacts.

Operating Position (E, Fig. 1)

As starting motor begins to crank engine shift sleeve is carried back to its original position by rotation of armature shaft and sleeve moves back and rotates as indicated by arrow. It is rotated by action of stud in shift lever and

spiral slot in shift sleeve. When engine fires, accelerating action disengages pinion from flywheel and pinion returns to locked or "at rest" position.

It is impossible to start another cranking operation until complete cranking cycle is finished. After engine fires, shift lever should be allowed to return to "at rest" position and unit is then ready for another cranking operation.

It is impossible to engage pinion while engine is running, for, as soon as pinion teeth touch moving flywheel teeth, shift sleeve is rotated and pinion follows armature shaft spline back to locked position (F, fig. 1).

Relative Position of Parts (F, Fig. 1)

This illustration does not represent a step in actual cranking operation, but merely shows position of the lock in shaft spline.

The engagement movement of shift lever is always against tension of shift lever return spring (B, fig. 1). When a cranking operation is completed, and shift lever is returned, continued tension of shift lever return spring creates a force on armature assembly towards commutator end of starting motor. This force is transmitted through armature brake directly against brake washer in commutator end of motor. The force of brake against brake washer stops armature almost immediately after shift lever is allowed to return. This feature makes starting motor immediately ready for another cranking operation in case engine does not continue to operate after it fires.

STARTERS

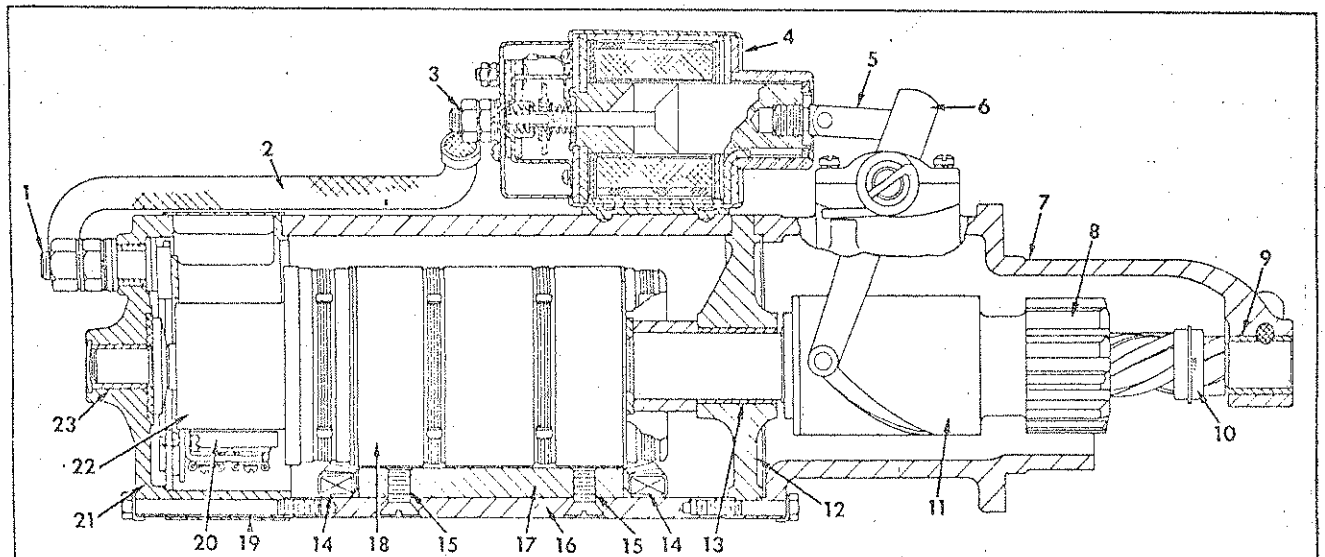
Starter, illustrated in figure 2, is solenoid operated "Dyer Drive" type. Solenoid, relays and shift mechanism operation are described under "Controls and Operation" previously in this section, also refer to "Operation" (Sec. O of this manual).

INSPECTION AND MAINTENANCE (ON VEHICLE)

Normal service may be obtained from starter with a minimum of trouble if regular lubrication, inspection and maintenance procedures are followed.

CLEANING

Exterior as well as the interior of the starter should be kept clean. Use a clean cloth dampened with cleaning solvent to wipe off excess grease. Do not steam clean or dip starter and avoid getting any water or cleaner in the starter. If interior of starter is dirty, remove, disassemble and clean all parts individually.

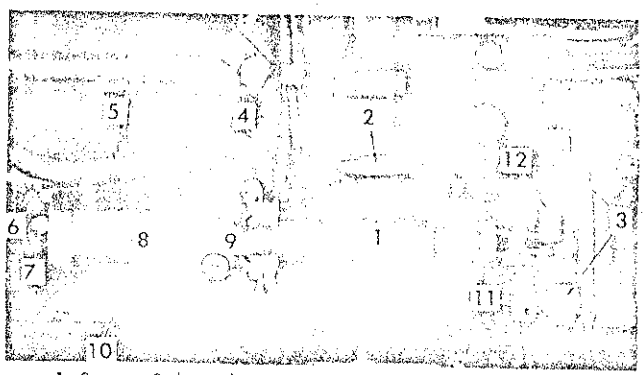


1 Starter Cable Terminal
2 Cable
3 Solenoid Cable Terminal
4 Starter Solenoid
5 Shift Link
6 Shift Lever
7 Drive Housing
8 Pinion
9 Bushing
10 Pinion Stop
11 Dyer Drive Assembly
12 Center Plate
13 Bushing
14 Field Coil
15 Pole Shoe Screw
16 Field Housing
17 Pole Shoe
18 Armature
19 Cover Band
20 Brush
21 Commutator End Frame
22 Commutator
23 Bushing

TP 1671-1

Figure 2—Sectional View of Starter

STARTING SYSTEM



1 Starter Solenoid
2 Name Plate
3 Attaching Stud Nuts
4 Battery Lead Wire
5 Solenoid to Starter Wire
6 Starter Terminal
7 Oil Cup
8 Starter
9 Solenoid Terminals
10 Cover Band
11 Shift Link
12 Shift Lever

TP 1961

Figure 3—Starter Installed

COMMUTATOR

The cover band should be removed and commutator inspected at 5,000 mile intervals. If commutator is dirty, clean with strip of No. 00 sandpaper - DO NOT USE EMERY CLOTH. All dust must be blown from starter after commutator has been cleaned.

BRUSHES

Replace worn brushes. Brushes may be seated by use of a brush seating hone. With starter operating at medium speed, press hone firmly against commutator to cover area contacted by brushes. Brushes should seat satisfactorily in a short period. Blow starter out with compressed air after using hone to remove all particles of abrasive. Do not use emery cloth or sandpaper to seat brushes. Check pigtail lead connections to be sure they are tight.

Brush Spring Tension

Check brush spring tension. Excessive spring tension will cause commutator and brushes to wear rapidly. Low spring tension will cause a reduced starter speed, also arcing and burning of commutator and brushes. Replace springs if tension is not as listed in "Specifications" later in this section.

MISCELLANEOUS

Make careful inspection of wires, terminals and all visible parts of starter. Any apparent defects should be corrected immediately.

Unusual noises in the starter may be caused by loose mountings. Worn or dirty bushings may cause noise or slow starter speeds and require cleaning and lubrication or, if worn excessively, replacement. Improperly seating brushes may cause slow starter speeds. Brushes can be reseated as previously explained under "Brushes" in this section. Bent brush holders should be replaced.

REMOVAL

1. Remove battery cable from solenoid terminal (fig. 3) and tape end to prevent accidental short and discharge of battery, or preferably disconnect ground cable at battery.

2. Remove three stud nuts attaching starter to flywheel housing. Move starter straight away from housing to complete removal.

BENCH TESTS

If starter does not operate properly, it should be removed from vehicle and tested on bench to localize trouble. Two bench tests - No-Load and Torque - should be made to determine condition of unit before disassembly.

NO-LOAD TEST

Connect the starter in series to a battery of the correct voltage and an ammeter capable of reading high amperage. If available, also connect a revolution counter. Note the revolutions and amperage draw with the starter running at free speed or no-load.

TORQUE TEST

If available, install starter in suitable test equipment to conduct stall test. The torque developed, current draw and voltage required should be noted.

Interpretation of No-Load and Torque Tests

Rated torque, current draw and no-load speed are listed in "Specifications" at end of this section. Interpretation of tests are as follows:

1. Low Free Speed and High Current Draw With Low Torque - May Result From:

a. Dirty, tight or worn bushings. Bent armature shaft or loose field coils and pole shoes.

b. Shorted armature. Check armature on growler after disassembly as instructed later under "Testing Parts" later in this section.

c. Grounded armature or field. Check by raising grounded brushes from commutator or disconnecting grounded connections where field is grounded by screws inside starter and testing with test light and points from starter terminal and housing, also from commutator to housing. If the test lamp lights, a ground exists.

2. Failure to Operate With High-Current Draw Indicates:

a. A direct ground in switch, terminals or brushes.

b. Seized bushings which prevent armature turning.

3. Failure to Operated With No-Current Draw Indicates:

a. Open field circuit. Inspect internal connections and trace circuit with test light.

b. Open armature coils. Check as later directed under "Testing Parts" in this section.

c. Broken or weakened brush springs, worn brushes, high commutator mica or other conditions which prevent good contact between brushes and commutator.

4. Low No-Load Speed With Low Torque and Low Current Draw Indicates:

a. Open-field winding. Raise and insulate ungrounded brushes from commutator and check fields with test light.

b. High internal resistance, due to poor connections, defective leads, dirty commutator, weak or broken brush springs and other causes that would produce poor contact between commutator and brushes.

c. Defective leads, broken or loose connections.

5. High Free Speed With Low Torque and High Current Draw Indicates:

a. Shorted fields. There is no easy way to detect shorted fields, since field resistance is already low. If shorted fields are suspected, replace the fields and check for improvement in performance.

DRIVE MECHANISM ADJUSTMENT

The drive is properly adjusted before leaving the factory.

When shift lever is in extreme forward position and switch contacts in solenoid are closed, there should be at least 1/8 to 3/16 inch travel of pinion against pinion spring pressure as indicated (fig. 1, D). This adjustment can be checked easily by disconnecting lead from solenoid to starting motor and using battery current through solenoid to hold shift lever in forward position. Since disconnecting this lead opens pull-in coil of the solenoid, it may be necessary to assist movement of plunger by hand to assure that plunger will reach its extreme travel position, closing the switch contacts. The starting motor armature will not revolve with this lead disconnected. The pinion travel can be checked by pushing pinion back against spring pressure. The adjustment can be changed by turning plunger stud in or out of solenoid plunger as necessary.

A test can be made to determine if engagement action is being completed before switch contacts are closed. This can be done by placing a 9/16 inch spacer between pinion and pinion stop. The shift lever can be moved forward then, forcing pinion against the spacer. It should not be possible to close switch contacts with spacer inserted. This adjustment can be changed by adjusting plunger stud as mentioned above.

When pinion is in operating position (fig. 1 E), there should be 1/32 inch clearance between pinion guide and bottom of slot at point indicated. If there is no clearance at this point, drive will be taken directly from hubs on pinion guide rather than from heavy spline in pinion itself. If it is found that there is no clearance at this point, the pinion and pinion guide should be replaced. The pinion with its lock and lock spring is released by moving pinion shift sleeve forward and along splines of shaft.

In assembling parts, pinion lock lugs should be in slots in the pinion hub with lugs toward pinion, or it will not be in the proper position to lock on the shaft.

DISASSEMBLY

1. Remove cable between solenoid and starter. Remove cotter pin and clevis pin attaching solenoid linkage to shift lever. Remove cap screws and lock washers attaching solenoid to housing, then remove solenoid.

2. Remove cap screws and lock washers attaching drive housing to starter housing. If necessary, tap housing with soft hammer to loosen then remove field housing from drive housing and armature.

3. Remove brush cover band by unsnapping catch. Note relationship of brush leads and brushes for reassembly purposes. Disconnect leads from field coil conductors. Remove cap screws and lock washers attaching commutator end frame to field housing, then separate these two parts. If necessary, tap with soft hammer to loosen while separating.

4. Remove nuts and washers from insulated terminal. Remove screws and lock washers attaching brush plate assembly to commutator end frame. Note position of insulators and washers for reassembly purposes. Remove brushes, springs and spring holders.

5. Remove shift lever assembly cover attaching screws and lock washers. Remove cover, shift lever shaft and return spring assembly.

6. Remove cotter pin attaching pinion stop to armature shaft. As armature is being removed from drive housing, slide pinion stop, pinion, pinion spring, guide, sleeve, and two thrust washers from armature shaft. Slide spacer and center bearing from armature shaft.

7. Remove field coils from field housing by removing pole shoe screws with pole shoe screw-

STARTING SYSTEM

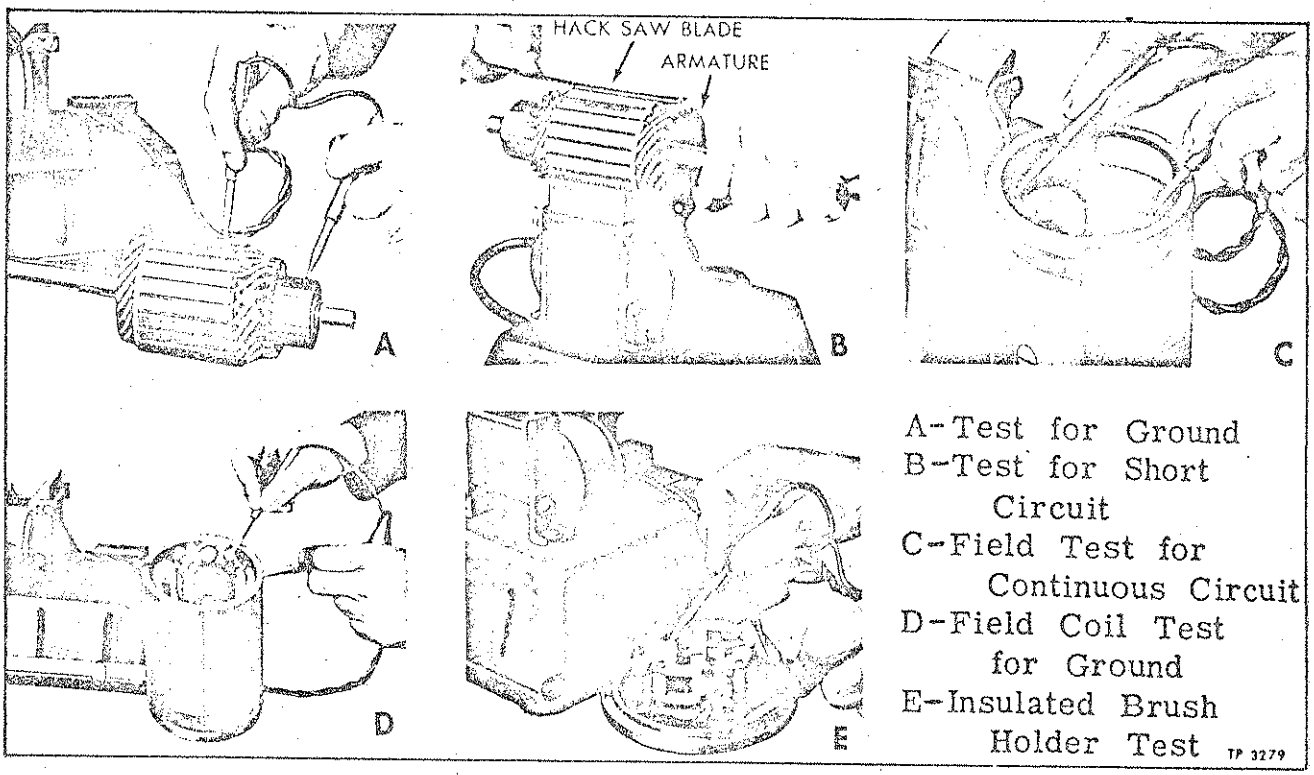


Figure 4—Starter Tests

driver. Remove pole shoes and field coils. Note position of insulating strips, if used, so they can be replaced in their correct location at time of reassembly.

INSPECTION

CLEANING

All parts, except field coils and armature, should be washed in cleaning solvent. Field coils and armature should be wiped clean with a rag.

ARMATURE

Check armature to commutator leads to be sure they are properly soldered. Loose leads should be resoldered as directed under "Repair" later in this section.

COMMUTATOR

Inspect commutator and if found to be rough, out-of-round, worn or has high mica, filled slots or is burned, it must be replaced or repaired as directed under "Repair" later in this section.

FIELD COILS

Use care in handling the coil assembly to avoid breaking or weakening the connecting straps between windings. The field insulation must be in good condition. If insulation is carcked, charred or worn so that windings are exposed, it is sometimes possible to repair them as directed under "Repair" later in this section.

BRUSHES

If brushes are worn down to less than half their original length, they must be replaced. Be sure that pigtail leads are secure in the brushes and that clips are properly soldered to the leads.

Brush Springs

Brush springs must have sufficient tension to provide proper pressure between brushes and commutator after the generator is reassembled. Replace springs if damaged or if tension is not as shown in "Specifications" later in this section.

Brush Holders

Carefully examine brush arms, arm pins, and holders for bent, warped or damaged condition. Any condition that might interfere with proper brush action should be corrected.

BUSHINGS

Carefully inspect bushings for evidence of wear. Install armature shaft into bushings and check clearance between bushings and shaft. If clearance is excessive, replace bushings as directed under "Repair" later in this section.

DYER DRIVE

Carefully inspect all parts of Dyer Drive for wear or other damage. Check spring for broken or weakened coils. Inspect pinion for worn or chipped teeth or splines.

MISCELLANEOUS

Carefully inspect insulators and insulating washers for damage or burned condition. Inspect all studs or screws for bent or damaged condition and cross threads.

TESTING PARTS

Starter parts may be tested with suitable electrical testing equipment. Illustrations showing application of test equipment are merely typical. Instructions furnished by manufacturer of test instruments used should be followed.

ARMATURE

Following armature tests should always be made while starter is disassembled.

Ground

Use conventional test light and prods and place one test prod on armature and other to commutator (fig. 4, A). If test light lights, armature is grounded and should be replaced, if defect is not readily apparent and repairable.

Open Circuited

An open circuit in the armature usually results in badly burned commutator bars and can be easily detected visually. If the bars are not badly burned, they can sometimes be corrected as directed under "Repair" later in this section.

Short Circuited

Place armature on growler connected to alternating current. Hold hack saw blade over armature while armature is rotated slowly (fig. 4, B). If saw blade vibrates or buzzes, it indicates that armature is short circuited. Before replacing an armature that is apparently shorted, inspect the commutator slots for copper or brush dust deposits. Clean thoroughly and again test.

FIELD COILS

Following field coil tests should be made while coils are installed in place in housing.

Continuous Circuit. Place test prods on field coil leads (fig. 4,C). If light does not light, field coils are open circuited and should be replaced.

Ground. Place one test prod on starter housing and other on field coil leads (fig. 4, D). If lamp lights, coils are grounded and should be replaced. When above test indicates that there is a ground in field coils, individual tests should be made to determine which coil is grounded. Break connection between coils and test each one separately.

TERMINAL TEST

Ground. Place one test prod on terminal and one on frame of starter. If test lamp lights, terminal insulation is broken and should be replaced.

BRUSH HOLDER TEST

Place one test prod on insulated brush holder and other on end frame (fig. 4, E). If test lamp lights, brush holder is grounded and hinge pin, insulation and stop pin should be replaced.

REPAIR

COMMUTATOR

Turning Down. Place armature in lathe and turn down to remove worn spots, out-of-round, rough or worn condition. Do not cut off more than necessary. If ends of commutator segments are less than 1/16" wide, the armature must be replaced.

Under Cut Mica. Mica between segments must be below the edge of segment. Start groove with a small three-cornered file, then use hack saw blade to undercut the mica until it is 1/32" below segment. Use No. 00 sandpaper to clean and smooth up commutator, then use compressed air to remove all fine particles of cuttings.

ARMATURE

Resoldering. When commutator riser bars are burned, this is often caused by an open-circuited armature. When the bars are not too badly burned, the armature can sometimes be saved by resoldering the leads in the riser bars, using rosin flux. After soldering turn down the commutator and undercut the mica.

FIELD COILS

Insulation. If the insulation is worn, so that the field wiring could become grounded, it can sometimes be repaired by rewrapping the field coils. Rewrapping must be done with extreme care and neatness, as excessive wrapping may hinder reassembling.

Connections. If connections between coils are loose, they can be resoldered. Always use rosin flux when soldering electrical connections; never use acid flux.

BUSHINGS

Removal. Remove oil wick from lubricant passage. Use arbor press to remove worn bushings from commutator end frame, center support and drive end housing.

Installation. Use arbor press to install new bushings and ream to provide running clearance to shaft. Drill oil hole through one wall of bushing. Install new oil wick in lubricant passage.

STARTING SYSTEM

REASSEMBLY

1. Install field coils and pole shoes in field housing using new insulation strips if used in same location as found at time of disassembly. Tighten pole shoe screws.

2. Install collar and center bearing assembly over armature shaft.

3. Place plain thrust washer and cupped thrust washer on armature shaft with cupped section of washer toward end of armature shaft. Position shift sleeve, pinion guide, spring and pinion on armature shaft. Pinion guide lugs must be toward the pinion. Align pinion guide lugs with slots in the skirt of the pinion. Hold pinion guide with thumb and fore-finger. Push pinion onto shaft, compressing the spring, until lugs are about midway of pinion slots then rotate the pinion and pinion guide onto the armature shaft splines. Continue twisting pinion until a click is heard which indicates that the pinion guide is locked in the undercut portion of the armature shaft and retains the entire assembly. Install the pinion stop on the armature shaft, align holes and install cotter pin, being sure cotter pin is bent ove. as far as possible.

4. Position armature shaft in drive end housing. Attach center bearing assembly to drive end housing with attaching bolts and install lockwire (if used) through bolt heads to prevent loosening.

5. Install shift lever and cover to drive housing, being sure end of lever is in circular slot of shift sleeve. Place spring on shift lever shaft with long tang on drive end frame boss. Twist spring and drop into slot in end of shaft. Position field housing against drive end housing as indicated by location of oiler on field housing. Install cap screws and lock washers attaching field housing to drive housing and tighten securely.

6. Assembly brush holders, brushes, insulating washers, etc., to commutator end frame in same position as noted at time of disassembly. Be sure all connections are tight and that insulators are properly located.

7. Locate commutator end frame against field housing with all others in alignment. Attach with cap screws and lock washers. Connect field coil leads and brush lead clips to brush holders.

8. Install solenoid to field housing and connect linkage to shift lever. Connect cable between solenoid and starter terminal.

9. Adjust linkage between solenoid and shift lever to provide proper clearances as directed in "Bench Tests" under "Drive Mechanism Adjustment" previously in this section.

INSTALLATION

1. Locate starter in position against flywheel housing. Install three stud nuts, using lock washers. Tighten cap screws or nuts evenly and alternately until tight.

2. Attach battery and solenoid cables to starter solenoid, there tighten terminal nuts.

STARTER SOLENOID AND RELAYS

Operation of starter is controlled by starter button, solenoid and relays, each of which performs a specific function. Refer to "Operation and Controls" previously in this section for specific purpose, description and operation for each of these control units. In addition, refer to "Operation" (Sec. O of this manual) for proper usage of the two starter buttons.

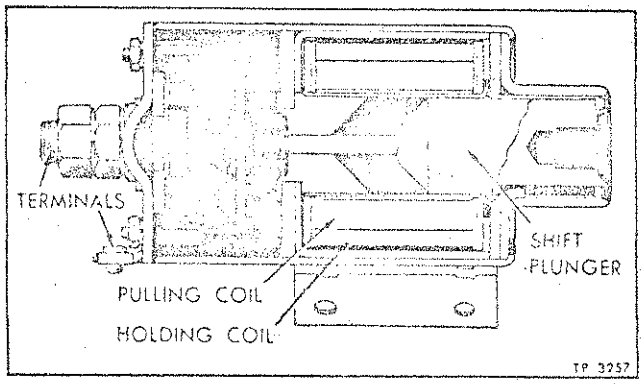


Figure 5—Starter Solenoid

SOLENOID

Solenoid (fig. 5) is mounted on starter housing as shown in figure 3. Operation of solenoid is fully explained under "Operation and Controls" previously in this section.

Maintenance

Solenoid requires no maintenance other than keeping contact points and terminals clean and tight. Always check action of solenoid if it has been removed and reinstalled. If unit fails to function, first check switches, relay and wiring before working on solenoid. Only test to make on solenoids is to check pull of solenoid coils with suitable equipment. Refer to "Specifications" later in this section for test data.

STARTER SOLENOID RELAY

The starter solenoid (fig. 6) is mounted on engine compartment panel located inside the baggage compartment at rear of vehicle. Refer to

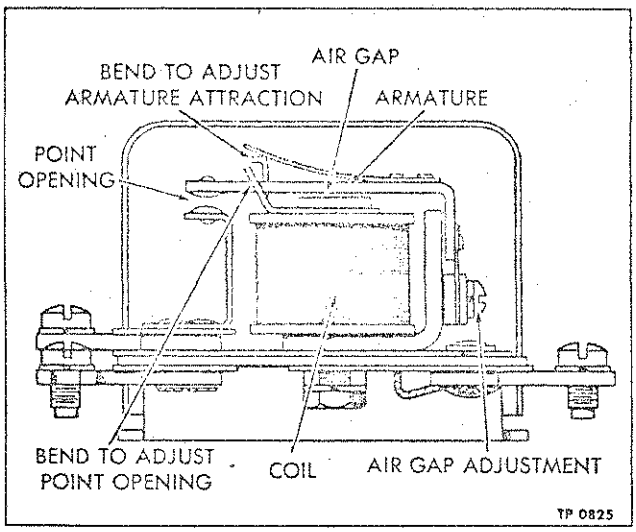


Figure 6—Starter Solenoid Relay

Wiring (Sec. 7A of this manual for wiring connections. Maintenance and adjustment operations are given below. Remove snap-on cover from relay to gain access to unit.

Air Gap Adjustment

With the contact points held closed, measure the air gap between the armature and center of coil. Adjust air gap by loosening two screws and move armature up or down as required (fig. 6). If necessary, align the support carrying the lower contact so that air gap will be uniform between the coil and the armature. Refer to "Specifications" later in this section, for correct air gap dimension.

Point Opening Adjustment

Measure the contact point opening with the armature in the open position. Adjust by bending armature stop (fig. 6). Refer to "Specifications" later in this section, for correct point opening dimension.

Closing Voltage Adjustment

With original leads connected to relay terminals, connect an accurate reading voltmeter at the relay terminals in parallel with the circuit. To check closing voltage, insert a variable resistance of 10 ohms (resistance should be capable of carrying 1 ampere) in series in relay circuit from battery. With push button switch pressed in, adjust resistance until the relay points close and note voltmeter reading. Adjust by bending armature spring to increase or decrease tension on armature (fig. 6). Increasing tension increases closing voltage and decreasing tension decreases closing voltage.

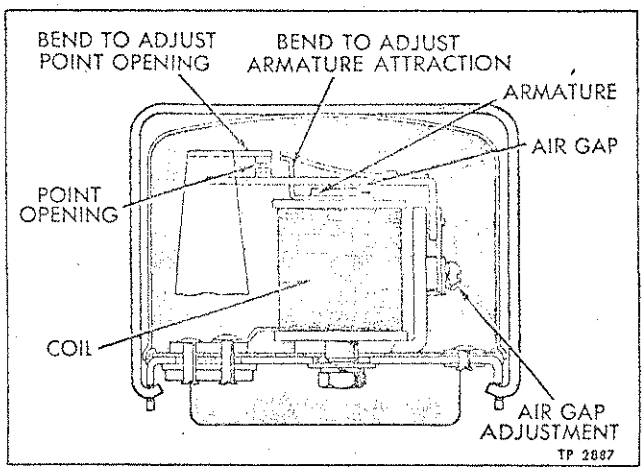


Figure 7—Starter Cut-out Relay

STARTER CUT-OUT RELAY

Starter cut-out relay (fig. 7) is mounted on engine compartment panel located inside the baggage compartment at rear of vehicle. Refer to Wiring (Sec. 7A of this manual) for wire and terminal connections. Maintenance and adjustment operations are given below. Release wire clamp for removal of cover to gain access to relay.

Air Gap Adjustment

Since relay is constructed so that contact points are normally closed, air gap adjustment as originally set should not require later adjustment. Position of armature can be changed, however, by loosening the screws and moving armature up and down as desired (fig. 7). Refer to "Specifications" later in this section, for correct air gap dimension.

Point Opening Adjustment

Measure the contact point opening with the armature in the down position. Refer to "Specifications" later in this section, for proper opening dimension. Adjust point opening by bending the support carrying the upper contact point (fig. 7). Clean contact points with a thin, fine-cut file if pitted or burned.

Opening Voltage Adjustment

Connect accurate reading voltmeter to the relay terminal marked "Gen" and to a convenient ground. Start the engine and gradually increase the speed until the contact points open. This is the opening voltage of the relay and it can be adjusted by increasing or decreasing the armature spring tension to obtain correct opening voltage (fig. 7). Refer to "Specifications" later in this section for correct opening voltage.

STARTING SYSTEM

SPECIFICATIONS

STARTER

Make	Delco-Remy
Number	1108735
Rotation - Viewed at Drive End	Counterclockwise
Brush Spring Tension	36-40 Ozs.

No-Load Test

Amperes	100
Volts	11.6
R.P.M.	5000

Lock Test

Amperes	570
Volts	2.3
Torque - Ft. Lbs.	20

STARTER SOLENOID

Make	Delco-Remy
Number	1118171
Max. Volts to Close @ 70°F	10.0
Air Gap	0.5"
Pounds Tension (Pull)	70
Current Consumption	
Both Windings @ 10 Volts	50.0 - 53.0 Amps.
Hold-in Winding @ 10 Volts	13.0 - 14.0 Amps.

STARTER SOLENOID RELAY

Make	Delco-Remy
Number	1850505(264-G)
Air Gap (With Points Closed)	0.012"
Point Opening	0.035"
Armature Attracted (Max. Volts	8.5
Armature Released (Volts)	3.5 - 4.2

STARTER CUT-OUT RELAY

Make	Delco-Remy
Number	1116757
Point Opening	0.030"
Armature Attracted (Max. Volts)	8 - 10

SERVICE BULLETINS

Service Bulletins are issued, whenever required, supplementing information in this section. The information contained in these bulletins should be noted in the text and bulletin filed for future reference—Make note of bulletin number in space below:

NOTES

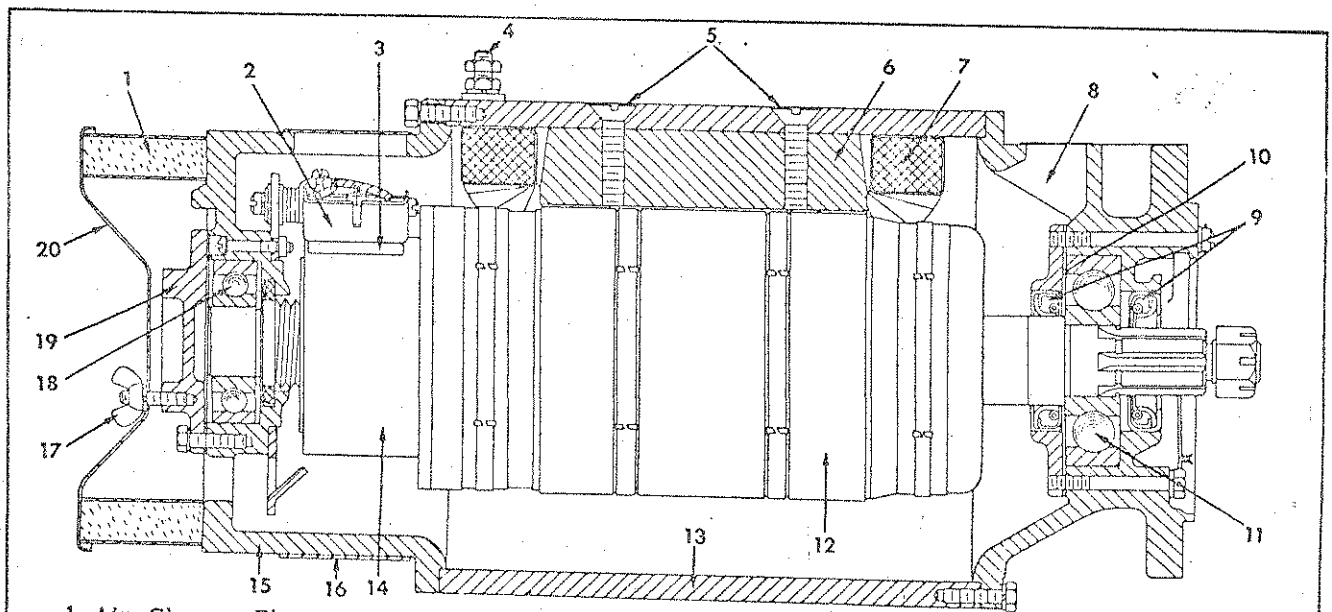
Generator

Contents of This Section

Related Subjects in Other Sections

Generator is a four brush, shunt type with external regulation. Armature shaft is supported by a single row ball bearing at each end. Output of generator is controlled by a generator regulator mounted at right rear corner of vehicle. Regulator service information will be found in Regulator (Sec. 7F of this manual).

Air for cooling and ventilating generator is drawn through unit by engine air intake system (fig. 1). Air entering generator must pass through an oil wetted air cleaner, mounted on commutator end of generator. Air is returned to engine air intake system through tube at drive end of generator. Generator is mounted on flywheel housing and is driven through gears connecting generator and engine balance shaft (fig. 2).



1 Air Cleaner Element
2 Brush Holder
3 Brush
4 Terminal
5 Pole Shoe Screws
6 Pole Shoe
7 Field Coil
8 Drive End Frame
9 Oil Seals
10 Bearing Retainer
11 Drive End Bearing
12 Armature
13 Housing
14 Commutator
15 Commutator End Frame
16 Cover Band
17 Air Cleaner Cover Retaining Nut
18 Commutator End Bearing
19 Commutator Bearing Retainer
20 Air Cleaner Cover

Figure 1—Sectional View of Generator

GENERATOR

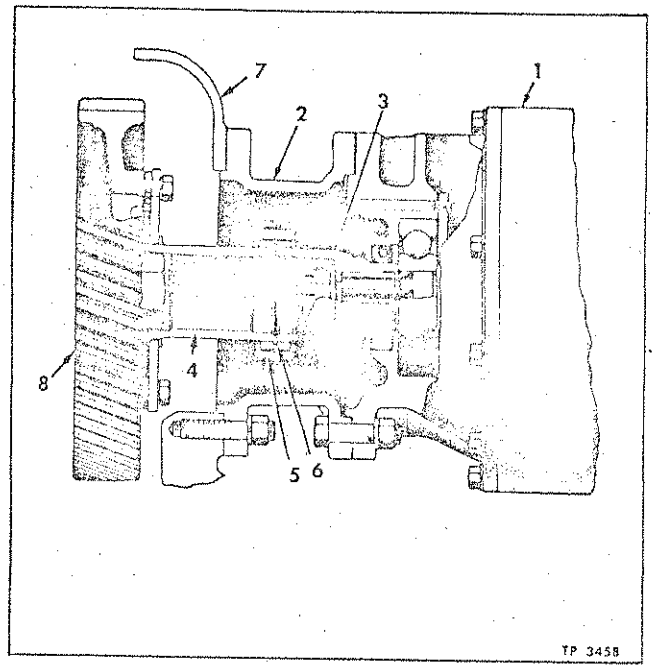


Figure 2—Generator Drive

INSPECTION AND MAINTENANCE

(On Vehicles)

Normal service may be obtained from generator with a minimum of trouble if regular lubrication, inspection, and maintenance procedures are followed.

AIR CLEANER

At regular specified intervals the air cleaner should be removed, cleaned and reinstalled. Refer to Fuel System (Sec. 12A of this manual for procedures. Refer to Lubrication (Sec. 13 of this manual) for interval of application and recommended lubricant.

CLEANING

Exterior as well as the interior of the generator assembly should be kept clean. Use a clean cloth, dampened with cleaning solvent, to wipe off excess grease. Do not steam clean or dip generator into a cleaning solvent. Avoid getting any water or cleaning solution in the generator. If interior of generator is dirty, remove, disassemble and clean all individual parts.

COMMUTATOR

The cover band should be removed and commutator inspected at 5,000 mile intervals. If commutator is dirty, clean with a strip of No. 00 sandpaper.

DO NOT USE EMERY CLOTH. All dust must be blown from generator after commutator has been cleaned.

BRUSHES

Replace worn brushes. Brushes may be seated by use of a "bedding" stone. Do not use emery cloth or sandpaper. With generator operating at medium speed, press bedding stone firmly against commutator to cover area contacted by brushes. Brushes should then seat satisfactorily in a short period. Blow generator out with compressed air to remove all abrasive particles after using stone. Check tightness of pigtail lead connections.

Brush Spring Tension

Check brush spring tension. Replace springs if tension is not as specified in "Specifications" at end of this section.

Excessive spring tension will cause commutator and brushes to wear rapidly; while low spring tension will cause a reduced generator output, also arcing and burning of commutator and brushes.

MISCELLANEOUS

Make careful inspection of wires, terminals and all visible parts of generator. Any apparent defects should be corrected immediately. A poor connection in charging circuit will cause generator to build up excessive voltage which may result in burned field or armature windings. A poor connection in generator field circuit will cause a low output.

Noise in generator may be caused by loose mounting or worn drive parts. Worn or dirty bearings which may cause noise, require cleaning and lubrication or, if worn excessively, replacement. Improperly seating brushes or bent brush holder may cause noise, requiring replacement.

GENERATOR DRIVE

Flange of generator drive end frame is bolted to an adapter, which is in turn bolted directly to flywheel housing. External teeth on generator drive hub and external teeth on drive coupling mesh with internal teeth of drive coupling ring to provide direct drive from engine balance shaft to generator, as shown in figure 2.

REPLACEMENT

REMOVAL

1. Remove bolts attaching air outlet hose fitting to generator.
2. Remove stud nuts and lock washers from three terminals on generator, then remove wires from each terminal. Tag each wire for identification at time of reinstallation.
3. Remove bolts, nuts, and lock washers attaching generator to generator adapter. Carefully pull generator straight away from engine to complete removal.

INSTALLATION

1. Position generator on adapter, making sure generator drive hub teeth mesh with coupling teeth. Install bolts, lock washers, and nuts. Tighten nuts evenly and alternately until tight.

2. Install wires on three generator terminals according to identification used at time of removal or refer to Wiring (Sec. 7A of this manual). Install lock washers and nuts and tighten securely.

3. Position air outlet fitting on generator drive end flame, install attaching bolts and lock washers, then tighten bolts securely.

4. Before starting engine, polarize generator.

POLARITY

When generator or regulator wires have been disconnected, especially when new unit is being installed, generator must be polarized after units are installed - BEFORE ENGINE IS STARTED. Failure to polarize generator will cause regulator points to vibrate excessively and burn. Remove wire from "F" terminal at generator. Use jumper wire to momentarily connect "F" terminal on generator and "Ammeter" terminal on regulator. This connection allows a momentary surge of battery current to reach generator fields, which automatically gives generator the correct polarity with respect to battery it is to charge. Reconnect wire to generator "F" terminal.

TESTING

Before generator is removed from engine, or with generator on bench, Operation Tests in the Regulator (Sec. 7F of this manual) should definitely establish which unit, generator or regulator is at fault. When it has been definitely established that generator is at fault, localize trouble in generator as follows:

1. NO OUTPUT

Remove cover band and check for sticking brushes, or for other causes of poor contact between commutator and brushes. Correct sticking brushes by cleaning brush holders and brush arms. Correct dirty armature as explained under "Inspection" later in this section. If trouble is still not corrected, test further as below:

a. Test for grounded armature by raising and insulating the grounded brushes from the commutator and checking with test points from "ARM" terminal to frame. If test lamp lights, raise other brushes and check "A" terminal and commutator separately.

b. Test for open field circuit with test points between "F" terminal and "G" terminal. If test lamp fails to light, field is open circuited. Replace field if defective.

c. Test for shorted field circuit with battery and ammeter connected in series with field circuit. A shorted field will draw excessive current, so care must be taken to avoid damaging ammeter. Refer to "Specifications" later in this section for current draw. If shorted field is found, replace.

d. An open circuit in the armature is usually readily apparent, as this condition usually causes burned armature bars.

e. If trouble has not yet been located, remove the armature and check on a growler for short circuit in manner described under "Testing Parts" later in this section.

2. EXCESS OUTPUT

Generator will produce excessive output due to an internal short that prevents generator regulator from inserting resistance into field circuit. This condition however, is very rare since the short would have to be between the insulated brush and "FLD" terminal of the field circuit to produce this result.

3. UNSTEADY OR LOW OUTPUT

Unsteady or low generator output may result from several conditions as follows:

a. Sticking brushes, low brush spring tension, dirty commutator or other conditions which prevent good contact between brushes and commutator. Correct as directed under "Inspection and Maintenance" previously in this section.

b. Rough, out-of-round, burned commutator, or if dirty between segment slots, or has high mica, may cause low or unsteady output.

DISASSEMBLY

1, Remove three wing nuts, then lift air cleaner cover and element from commutator end head. Loosen screw to remove cover band.

2. Remove screws and lock washers attaching commutator end head to field frame. If necessary, tap end frame with soft hammer to loosen, then remove end head assembly.

3. Remove cap screws and lock washers attaching bearing retainer to commutator end head. Remove retainer and gasket. Remove screws and lock washers attaching brush plate assembly to commutator end head. Remove brush plate assembly. Remove bearing assembly and felt seal washer from commutator end head.

4. Note position of grounded and insulated brushes also location of insulating washers so that they can be reassembled to their original position.

5. Remove cap screws and lock washers attaching drive head to field frame. If necessary, tap end head with soft hammer to loosen, then remove end head and armature.

6. Remove nut and washer on drive end of

armature shaft. Press armature out of drive end head, remove drive gear from armature.

7. Remove bolts and lock washers attaching bearing retainer to end head. Remove retainer with seal and gasket. Remove bearing from drive end head.

8. Field coils and pole shoes may be removed from the field frame by removing pole shoe screws and disconnecting field coil lead or removing stud. NOTE: Field coil test must be made before the field coils are removed from the generator.

INSPECTION

CLEANING

All parts except field coils and armature should be washed in cleaning solvent. Field coils and armature should be wiped clean with a dry rag.

ARMATURE

Check armature to commutator leads to be sure they are properly soldered. Loose leads should be resoldered as directed under "Repair" later in this section.

COMMUTATOR

Inspect commutator and if found to be rough, out-of-round, worn or has high mica, filled slots or is burned it must be replaced or repaired as directed under "Repair" later in this section.

FIELD COILS

Use care in handling the coil assembly to avoid breaking or weakening leads. The field insulation must be in good condition. If insulation is cracked, charred or worn so that wire is exposed, repair as directed under "Repair" later in this section or replace.

BRUSHES

Replace brushes if worn down to less than half their original length. Be sure that pigtail leads are secure in the brushes, and that clips are properly soldered to the leads.

Brush Springs

Brush springs must have sufficient tension to provide proper pressure between brushes and commutator after the generator is reassembled. Replace springs if damaged or if tension is not as shown in "Specifications" later in this section.

Brush Holders

Carefully examine brush arms, arm pins, and holders for bent, warped or damaged condition. Any condition that might interfere with proper brush action should be corrected.

BEARINGS

Carefully inspect ball bearing for evidence of damage, and wear. Replace if worn or damaged. Install end frame assembly on armature shaft to check clearance between bushing and shaft. If clearance is excessive replace bushing as directed under "Repair" later in this section.

SEALS

Felt Type

Carefully inspect felt seal for damage or excessive wear. If seal is worn or damaged it must be replaced as directed under "Repair" later in this section.

Lip Type

Inspect seals for wear, deterioration or damage to the sealing surface. Replace as directed under "Repair" later in this section if any damage is evident.

MISCELLANEOUS

Carefully inspect insulators and insulating washers for damage or burned condition. Inspect all studs or screws for bent or damaged condition and cross threads.

TESTING PARTS

Generator parts may be tested with suitable electrical testing equipment. Illustrations showing application of test equipment are merely typical. Instructions furnished by manufacturer of test instrument used, should be followed.

ARMATURE

Following armature tests should always be made while generator is disassembled.

Ground

With a conventional test light and prods, place one test prod on armature and other to commutator (fig. 3). If test light lights, armature is grounded and should be replaced.

Open Circuited

An open circuit in the armature usually results in badly burned commutator bars which can be easily detected visually.

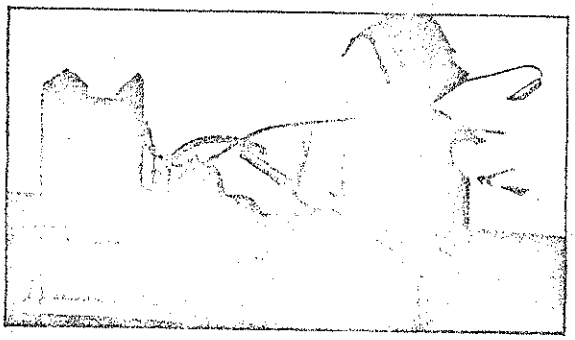
Short Circuited

Place armature on growler connected to alternating current. Hold hack saw blade over armature while armature is rotated slowly (fig. 3). If saw blade vibrates or buzzes, armature is short circuited. Before replacing an armature that is apparently shorted, inspect the commutator slots for copper or brush dust deposits. Clean thoroughly and again test.

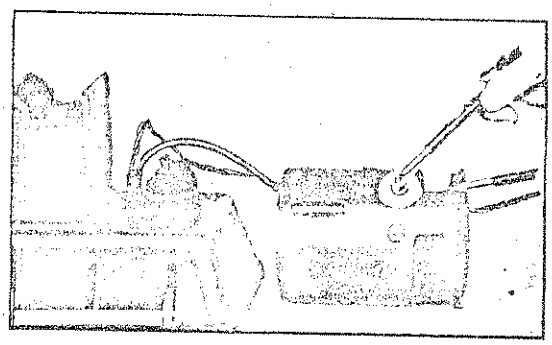
TERMINAL CIRCUIT TEST

Place one test prod on armature terminal and other on terminal of each wire (fig. 3). If test lamp does not light, wire is open circuited and should be replaced.

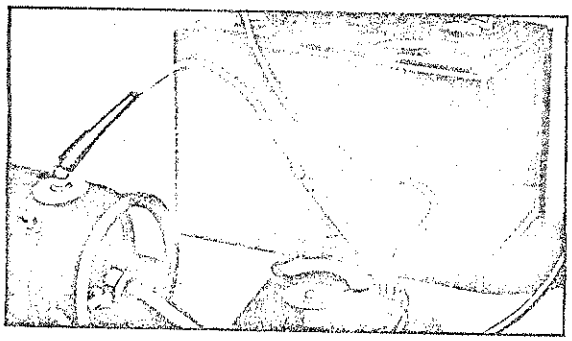
GENERATOR



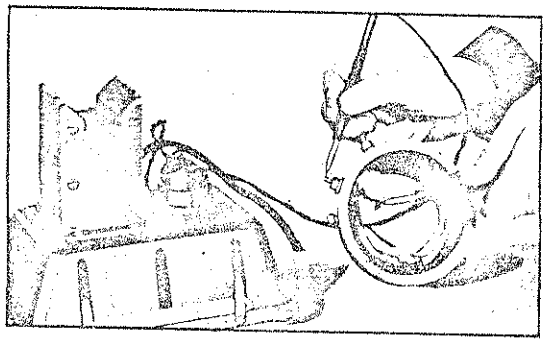
FIELD COIL TEST FOR CONTINUOUS CIRCUIT



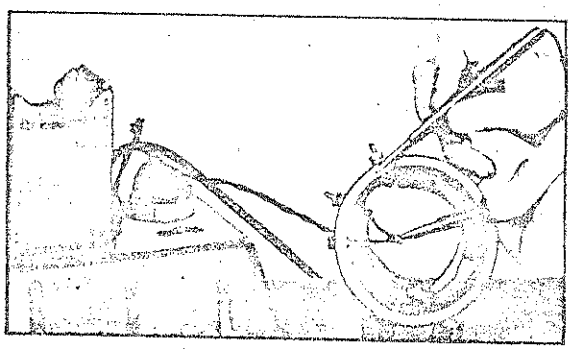
FIELD COIL TEST FOR GROUND



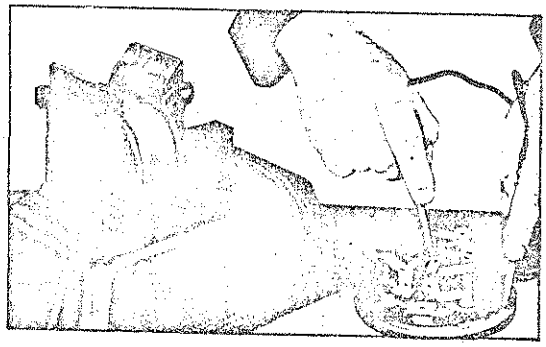
FIELD COIL BALANCING TEST



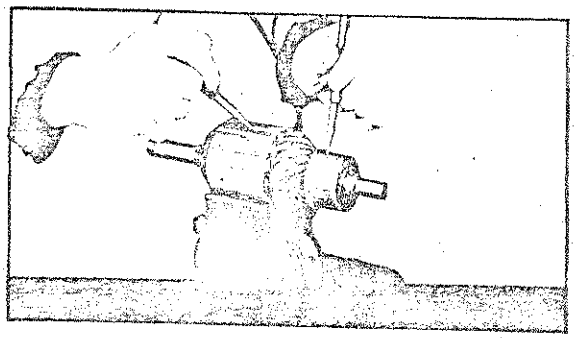
TERMINAL TEST FOR CONTINUOUS CIRCUIT



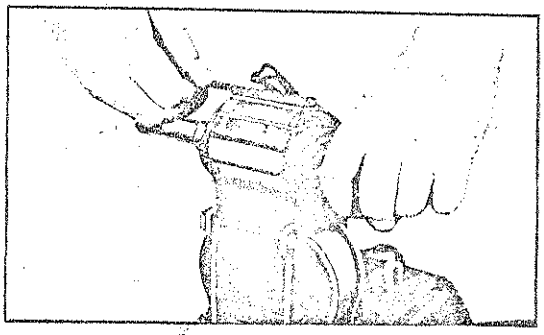
TERMINAL TEST FOR GROUND



INSULATED BRUSH HOLDER TEST



ARMATURE TEST FOR GROUND



ARMATURE TEST FOR SHORT

Figure 3—Generator Tests

GENERATOR

FIELD COILS

Following field coil tests should be made while coils are installed in place in housing.

Continuous Circuit

Remove grounded end of field coil from inside of field frame. Place test prods on field coil terminals as illustrated in figure 3. If test lamp does not light, field coils are open circuited and should be replaced.

Ground

Disconnect grounded end of field coil winding from housing. Place one test prod on generator housing and other on field terminal (fig. 3). If test lamp lights, field coils are grounded and should be replaced.

Current Draw Test

Remove grounded end of field coil from inside of field frame. Place test lead on ground terminal and other test lead on "F" terminal, with ammeter connected (fig. 3). Take ammeter reading. Remove test leads and securely reconnect ground lead to inside of field frame. Field coils should draw current as indicated in "Specifications" later in this section. Replace if they do not meet "Specifications."

BRUSH HOLDER TEST

Place one test prod on insulated brush holder and other on end frame. (fig. 3). If test lamp lights, brush holder is grounded and should be replaced.

REPAIR

COMMUTATOR

Turning Down. Place armature in lathe then turn down to remove worn spots, out-of-round, rough or worn condition. Do not cut-off more than necessary. If end of commutator segments are less than 1/16" wide the armature must be replaced.

Undercut Mica. Mica between segments must be below the edge of segment. Start groove with a small three-cornered file, then use hack-saw blade to undercut the mica until it is 1/32" below segment. Use No. 00 sandpaper to clean and smooth up commutator, then use compressed air to remove all fine particles of cuttings.

ARMATURE

Welding Leads. When commutator riser bars are burned this is often caused by an open-circuited armature due to excessive output. When the bars are not too badly burned, the armature can sometimes be saved by rewelding the leads in the riser bars. After welding turn down the commutator and under-cut the mica until it is 1/32" below segments.

FIELD COILS

Insulation. If the insulation is worn so that the field wiring could become grounded coil can sometimes be repaired by rewrapping the field coils. Rewrapping must be done with extreme care and neatness, as excessive wrapping may hinder reassembling.

Connections. If connections between coils are loose, resolder. Always use rosin flux when resoldering electrical connections - NEVER USE ACID FLUX;

SEALS

Felt Type. Remove felt seal and retainer using punch to drive out retainer. Use file or stone to remove any metal staked over at time of installation.

Install felt seal in retainer, then press retainer, and seal in place. Press retainer until it is seated or is flush with part into which it is being installed. Use prick punch to stake retainer in place.

Lip Type. Use drift or punch to drive lip type seals from drive end head.

Install new seal assemblies with lips of seals toward bearing. Position seals on end head and press in to place with suitable replacing tool or drive seals into place with block of hard wood and hammer. Seals are properly positioned when edge of seals are flush with end head.

REASSEMBLY

1. Install field coils and pole shoes in field frame (housing) and attach with pole shoe screws. Install "F" terminal in field frame, being sure it is properly insulated from field frame. Attach field coil ground wire to the field frame. If the field coil leads have been separated, they should be soldered and insulated.

2. Install bearing in drive end head. Position bearing retainer and seal assembly against inside of drive end head, using gasket between the two parts. Secure retainer to end head with cap screws and lock washers. Thread soft wire through drilled head of screws to prevent loosening.

3. Apply small quantity of engine oil to leather seals and contacting surface of armature shaft. Install armature shaft through drive end head, being sure that seals are not damaged. Install drive gear and secure with new self locking nut. IMPORTANT: Use torque wrench and tighten gear nut to 180 ft. lbs.

4. Position field frame over armature with drive end head properly located against field frame. Install cap screws and lock washers then tighten alternately and evenly.

5. If commutator end head has been disassembled it should be reassembled at this time. Be sure that brushes, brush holders and insulating washers are assembled in their proper position as noted at time of disassembly.

6. Install bearing in commutator end head. Position bearing retainer to commutator end head, using gasket between these two parts. Secure retainer to commutator end head with cap screws and lock washers.

7. Apply small quantity of engine oil to felt seal and contacting surface of armature shaft. Install armature shaft into commutator end head bearing, being sure that felt seal is not damaged. Install cap screws and lock washers then tighten alternately and evenly.

8. Install cover band. Install air cleaner element and air intake cover.

9. Before installing generator, check as described under "Testing" earlier in this section.

SPECIFICATIONS

Make	Delco Remy
Model	1117566
Rotation (Viewed at Drive End)	Counterclockwise
Brush Spring Tension (Oz)	25
Field Current @ 12 Volts (Amps)	1.78 - 1.92
COLD OUTPUT	
Amperes	120
Volts	13
R.P.M. (Approx.)	850
HOT OUTPUT	
Maximum Output Controlled by Current Regulator	

SERVICE BULLETINS

Service Bulletins are issued, whenever required, supplementing information in this section. The information contained in these bulletins should be noted in the text and bulletin filed for future reference - Make note of bulletin number in space below:

NOTES

Regulator

Contents of This Section

Related Subjects in Other Sections

The generator regulator, used on these vehicles as standard equipment, is five unit type, consisting of voltage regulator, field relay, current regulator, cutout solenoid and actuating relay (fig. 1). Unit is mounted on an engine compartment panel at right rear corner of vehicle. Regulator is accessible, through a door at corner of vehicle.

Regulator controls generator output, varying output to meet demands of the electrical system and battery. Output of generator is not increased by regulator - regulator serves only to reduce generator output when full output is not required by electrical system.

Wiring diagram of generator and regulator units is shown in figure 2.

OPERATION

Field Relay

The field relay is a unit to control field current. The field current is carried through field relay contacts, and relay is operated by voltage regulator, which is connected directly across generator.

Voltage Regulator

The voltage regulator increases, or decreases generator output in accordance with battery requirements and the connected electrical load.

Current Regulator

The current regulator limits the generator output to a specified value, which is governed by the setting of the regulator.

Actuating Relay

The actuating relay is connected across generator so that when sufficient voltage is generated to charge battery the relay points close and energize the cut-out solenoid. When the generator voltage falls below a value sufficient to charge the battery the actuating relay points open to break circuit between generator and battery.

Cut-Out Solenoid

When cut-out solenoid is energized by actuating relay, as described above, multiple contact points are closed to complete the circuit between generator and battery. As generator voltage falls below a value sufficient to charge battery, the contact points are opened by action of actuating relay, thus circuit between generator and battery is broken.

INSPECTION ON VEHICLES

In general, avoid tampering with a regulator that is functioning properly. However, periodic inspection can add greatly to the life of the regulator by disclosing conditions which if not cor-

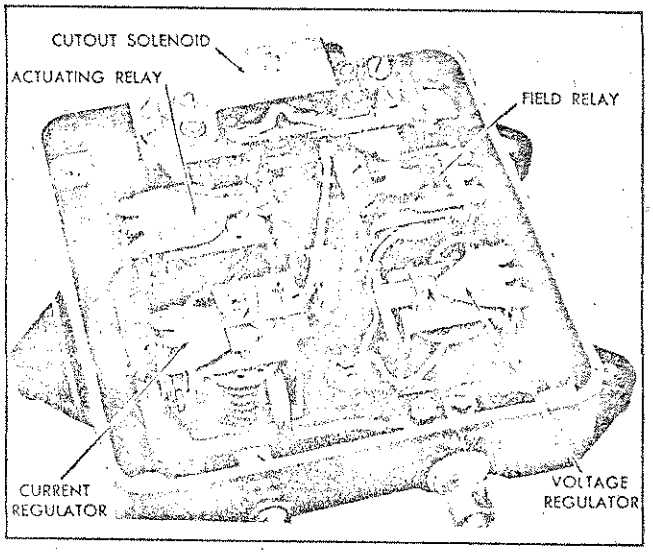


Figure 1—General View of Regulator

REGULATOR

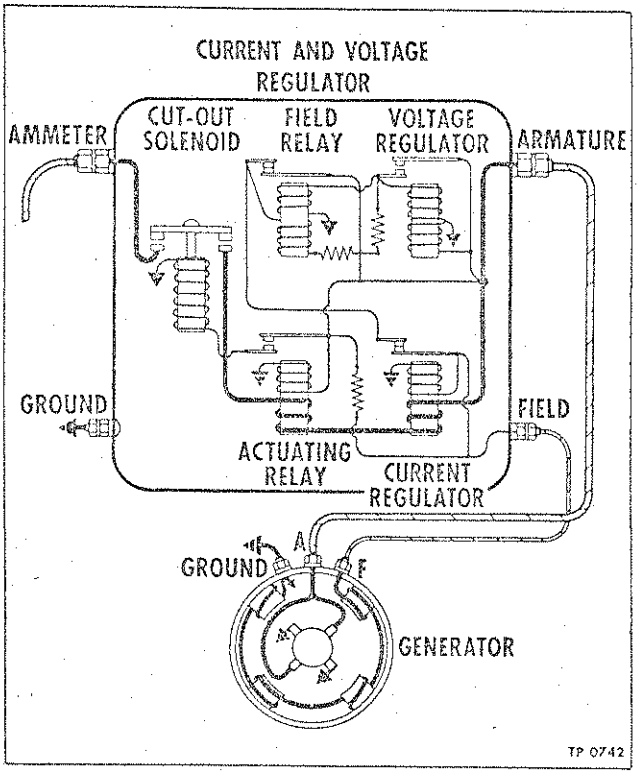


Figure 2—Generator and Regulator Wiring Diagram

rected, would result in damage to regulator, generator, or other units of the electrical system.

Regulator cover should be removed and visual inspection made for dust or corrosion of units, and with engine running, condition and action of points. Terminal mounting, and cover screws should be tightened. This inspection coupled with a check of battery and generator will afford a good indication of correct generating system operation.

COVER INSPECTION

Regulator may become inoperative in service due to dust or moisture collecting inside unit; improper sealing of gasket between cover and regulator base being the major contributing factor. Examine gasket carefully for defect - evidence of poor sealing can usually be found on gasket. Replace gasket if found defective.

Inspect cover and make certain it is not distorted or damaged. Install cover and attaching screws, tightening screws firmly and with equal tension. Press on each end of cover after tightening screws. If cover can be moved, it is evidence of a poor seal.

TERMINALS

Regulator terminals must be kept tight and clean to insure proper functioning of regulator. Remove all traces of corrosion from both wire and regulator terminals. Replace any wiring that shows evidence of swollen or worn insulation. CAUTION: If wires are disconnected, polarize generator as directed in "Polarity," before starting engine.

POLARITY

Whenever generator or regulator are tested or replaced or when wires have been disconnected, generator must be polarized to insure correct polarity with respect to electrical system. GENERATOR MUST BE POLARIZED BEFORE ENGINE IS STARTED. Remove wire from "F" terminal at generator. Use jumper wire to momentarily correct "F" terminal on generator and "Ammeter" terminal on regulator. This allows a momentary surge of battery current to flow to generator field windings, which automatically gives generator correct polarity with battery it is to charge. Failure to do this will cause the cut-out solenoid and actuating relay contacts to vibrate and burn so that they will be seriously damaged.

ARCING AND ACTION OF POINTS

Excessive arcing or sluggish action of contact points in either current or voltage regulator units is an indication of one of the following:

1. Resistance unit is open.
2. Defective winding in regulator.
3. Contact points pitted or oxidized.
4. Contact points incorrectly aligned, or meeting with improper pressure.
5. Shorted field coil in generator.
6. Poor ground connection between generator and regulator.

Cleaning Contact Points

Regulator contact points should be inspected for evidence of dirt, oxidation, and pitting or burning, and cleaned whenever necessary. Dirty or oxidized points arc and burn, causing reduced generator output and run-down battery.

Contact points are removable and may be cleaned with a flat file. Do not use a file that is oily or greasy, and avoid filing away more material than is necessary to remove pits from points. NEVER USE SANDPAPER OR EMERY CLOTH TO CLEAN CONTACT POINTS.

OPERATION TESTS

Tell-tale light on instrument panel merely indicates whether or not generating system is functioning. However, in combination with a battery test, tell-tale light serves to indicate possible malfunctioning of battery, generator or regulator.

Operating Temperature

Before any attempt is made to check regulator current and voltage settings, it is important that unit be at operating temperature (135° to 145°). Operate unit for at least 30 minutes to obtain operating temperature.

Fully Charged Battery and Low Charging Rate

Above condition indicates that generator and regulator are functioning properly. Verify this by noting charging rate at medium generator speed. Then crank engine with starting motor for about 10 seconds to partly discharge battery. Run generator again at medium speed and note charging rate. Since battery voltage has been lowered, generator output should show an increase for a short period.

Check current regulator unit by bridging field relay points (fig. 16). Turn on all lights or other electrical loads and increase generator speed until output remains constant. The output reading is the value for which current regulator is set. Refer to "Specifications" later in this section for correct setting.

If output fails to increase to specified value, current regulator setting is probably low. Adjust current regulator as specified under "Current Regulator Current Setting" later in this section. If it is impossible to adjust regulator to specified output, check conditions as outlined under "Low Battery and Low or No Charging Rate" later in this section.

Fully Charged Battery and High Charging Rate

Above condition indicates that voltage regulator unit is not reducing generator output as it should. A high charging rate to a fully charged battery will cause battery to gas and overheat. It also produces excessive voltage in electrical circuit which is very injurious to all electrical units.

A fully charged battery and high charging rate can be caused by one of the following conditions:

1. Voltage regulator out of adjustment.
2. Defective winding in voltage regulator unit which prevents unit operating.
3. Direct short between charging circuit and field circuit, either in regulator or generator, which prevents resistance being inserted into field circuit when contact points open.
4. Poor ground connection between generator and regulator.
5. High temperature which reduces the resistance of the battery to charge so that battery will accept a high charging rate, even though the voltage regulator setting is normal.
6. If the cause of the trouble cannot be considered due to temperature, proceed as follows to locate trouble.

a. Remove lead from regulator "Field" terminal while generator is operating at medium speed.

b. If the output remains high, the generator or wiring is at fault. Reconnect wire to regulator. Remove wire from "F" terminal of generator to determine if fault is with generator or wiring. If output drops off, the wiring is at fault or if output remains high, the generator is at fault.

c. If output drops off with lead removed from regulator "Field" terminal (a. above) the regulator is at fault and should be inspected for burned leads, windings or insulation.

Low Battery and High Charging Rate

This is an indication of normal generator regulator operation. However this condition should not be prolonged as the high charging rate should soon charge the battery and therefore return to a low charging rate and fully charged battery. Failure of battery charge to be restored indicates that regulator is improperly adjusted or that battery is faulty.

Low Battery and Low or No Charging Rate

Check circuit for loose connections, frayed or damaged wires, low regulator setting or oxidized contact points, if above condition exists. High resistance in charging circuit, due to these conditions, will cause voltage regulator to operate as though battery were fully charged, reducing generator output, even though battery is in a partly discharged condition. If trouble is not in wiring, make following checks.

Bridge regulator terminals marked "ARMATURE" and "FIELD" temporarily with a jumper lead while generator is operating at medium speed. Bridging terminals removes all external regulation and may allow generator output to reach an excessive value. With terminals bridged, one of the two following actions will result. Generator output will increase to or above or will not increase to its specified value. Check each condition in the following manner.

1. If generator output increases to or above its specified value this indicates one of the following conditions:

a. Voltage or current regulator is adjusted for too low a value.

b. Oxidized regulator contact points which insert excessive resistance in generator field circuit.

c. Generator field circuit open within the regulator, either at the connections or in the regulator windings.

2. If generator output does not increase to its specified value this indicates that generator or actuating relay or cut-out solenoid is at fault,

REGULATOR

a. If actuating relay points are closed and there is no charging current this indicates that circuit is open between regulator and battery.

b. If contact points are open connect a voltmeter between "ARMATURE" terminal on regulator and convenient ground on generator to check voltage build-up. If voltage is satisfactory without causing actuating relay or cut-out solenoid to close it indicates that these units are out of adjustment or unit windings are open. CAUTION: Do not close relay points manually while battery is connected.

MECHANICAL ADJUSTMENTS

(Air Gap And Point Opening)

Air gap and point opening must be set before attempting to adjust current and voltage settings. REGULATOR MUST BE DISCONNECTED DURING THESE ADJUSTMENTS.

Adjustment of regulator air gap and point opening can be made at bench if regulator has been removed; however, final electrical adjustments should be made, with unit installed in its proper position in vehicle. The regulator must be disconnected from battery before any mechanical adjustments (air gap and point opening) are made.

Field Relay Air Gap Adjustment

1. Measure air gap between brass residual pin in armature and magnetic core (fig. 3). This dimension should be as listed under "Specifications" later in this section.

2. If air gap requires adjustment, loosen two lock nuts and turn contact screws until proper adjustment is obtained (fig. 3). Tighten lock nuts when adjustment has been completed.

3. If the proper air gap cannot be obtained by adjustment of the two contact screws, loosen the two screws that attach the upper contact bracket to the frame and raise or lower the bracket as required.

4. Point opening of each set of points must be identical so that each point carries half the current. A final check must always be made after the regulator is installed and in operation. If more arcing takes place at one set of points than other it indicates that it is carrying more current than other and must be readjusted so that they are equal.

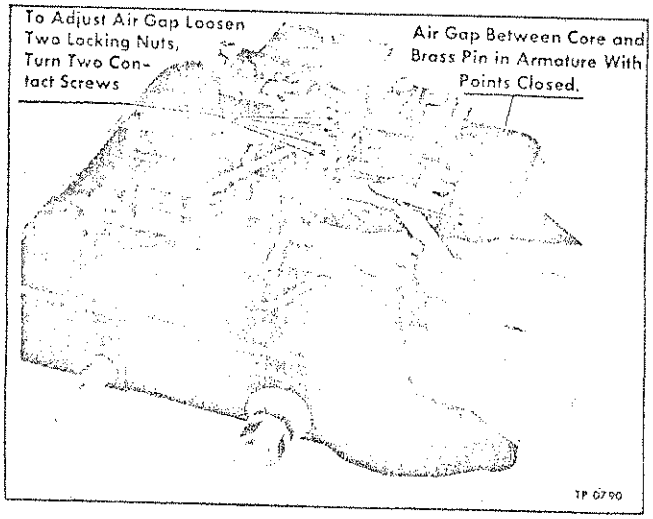


Figure 3—Field Relay Air Gap Check and Adjustment

Voltage Regulator Air Gap Adjustment

1. Press armature down until contact points touch, then measure air gap between armature and brass residual pin in core (fig. 4). This dimension should be as listed under "specifications" later in this section.

2. If air gap requires adjustment, loosen two adjusting screws (fig. 4) holding lower contact bracket. Adjust bracket up or down until gap is as specified under "Specifications" later in this section. Be sure screws are tightened well after adjustment.

Voltage Regulator Point Opening Adjustment

1. Check point opening as shown in figure 5. Opening should be same as listed under "Specifications" later in this section.

2. To adjust, bend armature stop (fig. 5) until proper point opening is obtained.

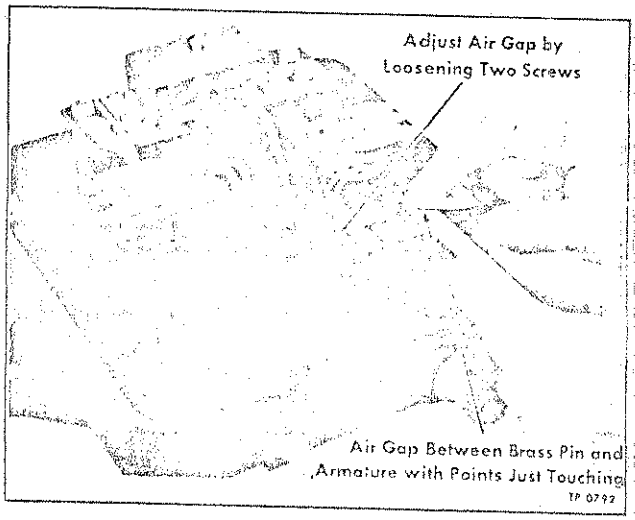


Figure 4—Voltage Regulator Air Gap Check and Adjustment

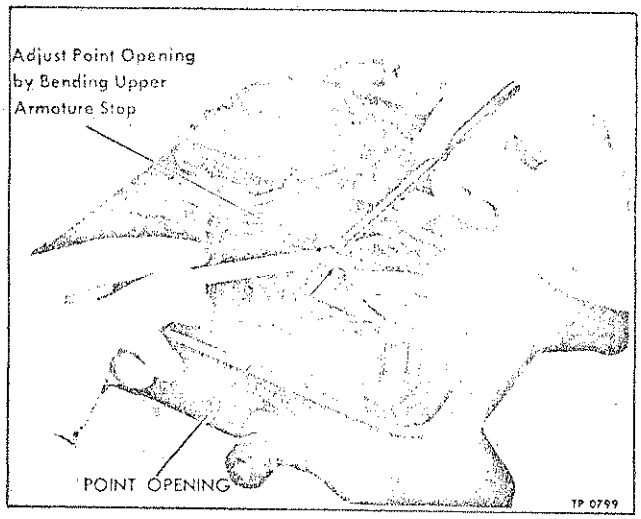


Figure 5—Voltage Regulator Point Opening Check and Adjustment

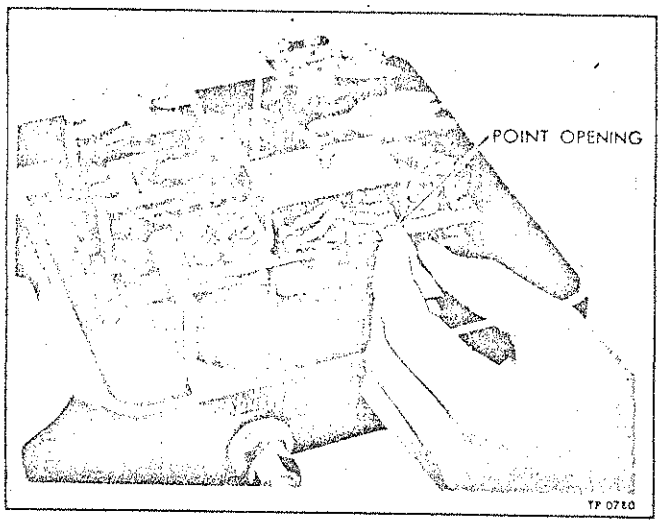


Figure 6—Cut-out Solenoid Point Opening Check

Cut-Out Solenoid Point Opening

1. Measure point opening gap with feeler gauge (fig. 6). This dimension should be as listed under "Specifications" later in this section.

2. If point opening requires adjustment, loosen adjusting screw lock nut and turn adjusting screw in or out as necessary until proper point opening is obtained (fig. 7). Tighten lock nut when adjustment has been completed.

3. Point opening of each set of points must be identical so that points carry equal current.

4. Check guide pin for straightness so that it does not bind and prevent free plunger travel.

Actuating Relay Air Gap Adjustment

1. Press armature down UNTIL POINTS JUST MEET and measure air gap between core and brass residual pin on armature (fig. 8). This dimension should be as listed under "Specifications" later in this section.

2. Adjust bracket up or down until gap is as specified under "Specifications" later in this section. Be sure screws are tightened after adjustment.

Actuating Relay Point Opening

1. Check point opening using feeler gauge (fig. 9). Opening should be same as listed under "Specifications" later in this section.

2. To adjust, bend armature stop (fig. 9) until proper point opening is obtained.

Current Regulator Point Opening

1. Check point opening with armature held down against core (fig. 10). Opening should be same as listed under "Specifications" later in this section.

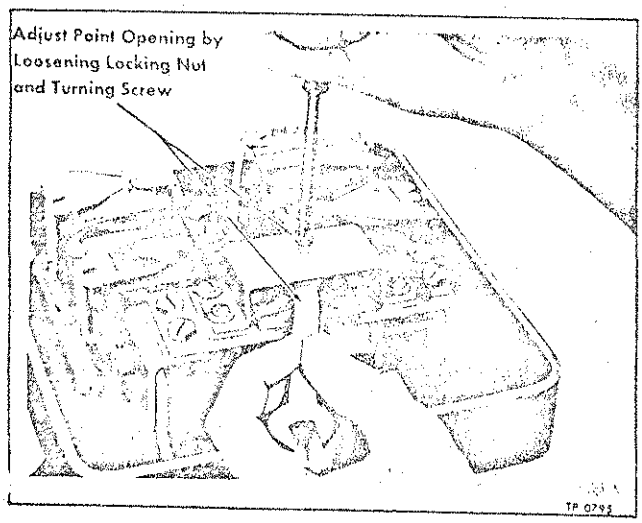


Figure 7—Cut-out Solenoid Point Opening Adjustment

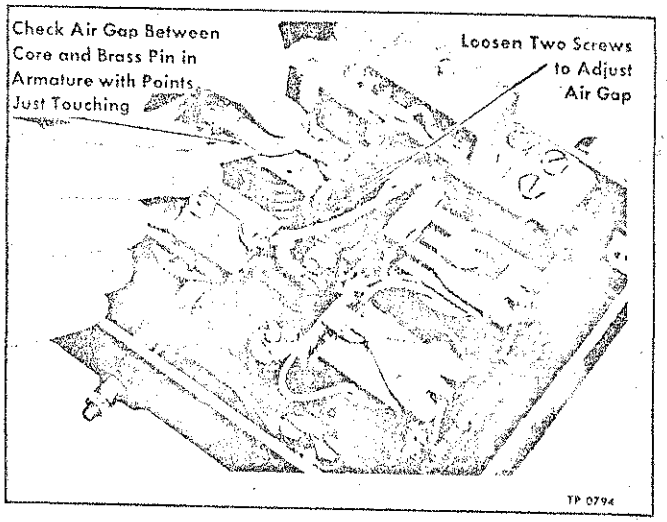


Figure 8—Actuating Relay Air Gap Check and Adjustment

REGULATOR

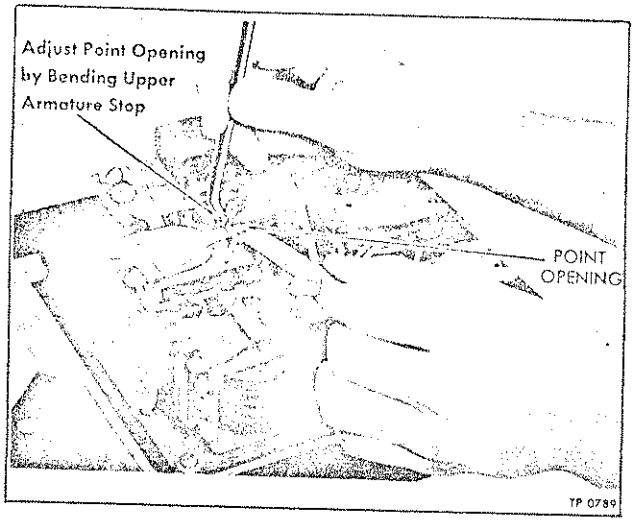


Figure 9—Actuating Relay Point Opening Check and Adjustment

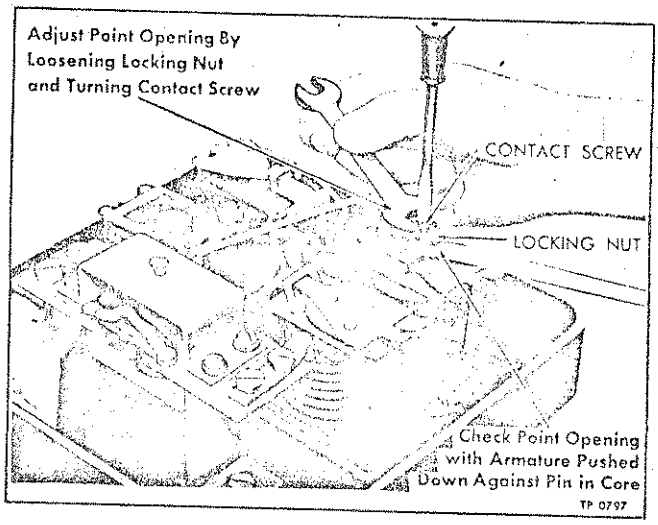


Figure 10—Current Regulator Point Opening Check and Adjustment

2. To adjust, loosen lock nut and turn contact screw (fig. 10) until gap specified under "Specifications" later in this section has been obtained. Tighten lock nut when point opening is correct. Press down armature and again check point opening.

ELECTRICAL ADJUSTMENTS

(Current And Voltage)

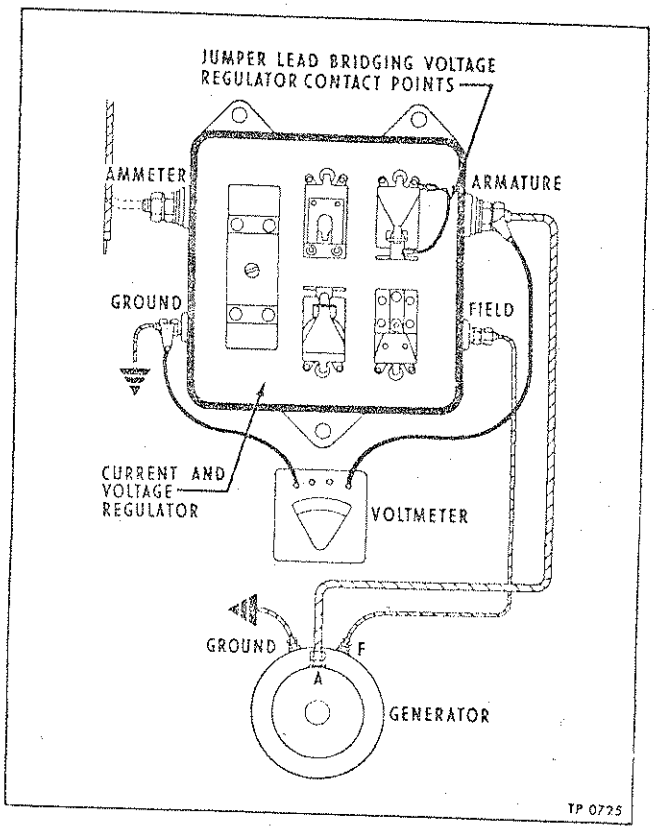


Figure 11—Meter Connection for Field Relay Electrical Check

When making current and voltage adjustments, obviously the regulator must be connected to generator and battery of proper voltage and with correct terminal grounded as specified on regulator model plate.

Air gap and point opening adjustments must have been completed as described under "Mechanical Adjustments" previously in this section.

CAUTION: Never close actuating relay or cut-out solenoid points by hand while regulator is connected to the battery. This would allow sufficient current to flow from the battery to cause serious damage to the regulator units.

Operating Temperature. Before any attempt is made to check regulator current and voltage settings it is important that unit be at operating temperature (135° to 145°). Operate unit for at least 30 minutes to obtain operating temperature.

Sequence of electrical adjustment (current and voltage checks) must be made in the following order.

1. Field relay operating voltage.
2. Voltage regulator voltage setting.
3. Cut-out solenoid operating voltage.
4. Actuating relay operating voltage.
5. Current regulator current setting.

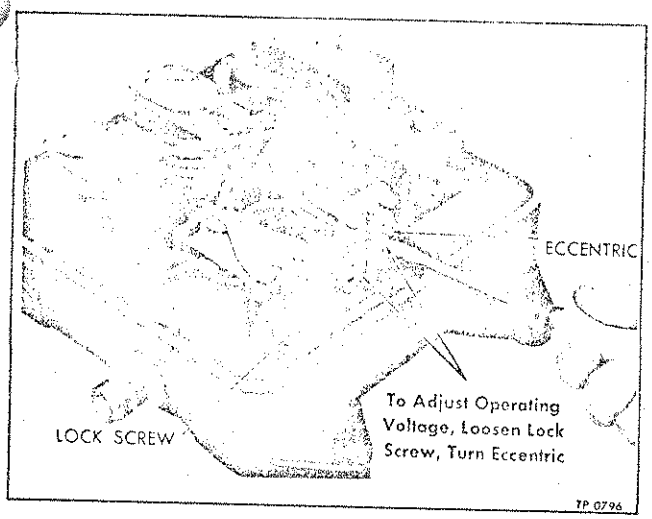


Figure 12—Field Relay Operating Voltage Adjustment

Field Relay Operating Voltage

1. Connect a jumper lead between voltage regulator points (fig. 11) to prevent regulator operation.

2. Disconnect battery lead at regulator "Ammeter" terminal. Connect a test voltmeter between regulator "Armature" terminal and "ground" (fig. 11).

3. Run generator at about 1275 R.P.M. and note operating voltage. Refer to "Specifications" later in this section for correct voltage.

4. To adjust, loosen lock screw and turn eccentric screw to change spring tension (fig. 12). Increasing tension increases voltage setting, decreasing tension lowers voltage setting.

5. Tighten lock screw and check setting by stopping generator and then bring it back to speed, to again check voltage setting. Remove jumper lead when setting has been completed.

Voltage Regulator Voltage Setting

1. Connect a test voltmeter between "armature" terminal and "ground" screw, and disconnect lead from "ammeter" terminal (fig. 13).

2. Run generator at approximately 1275 R.P.M. and note voltage setting. Refer to "Specifications" later in this section.

3. To adjust, loosen lock screw and turn eccentric screw to change spiral spring tension. Increasing tension increases voltage setting, decreasing tension lowers voltage setting.

4. Tighten lock screw and check setting by reducing generator speed until actuating relay points open, then bringing generator back to speed.

Voltage setting of 15 volts as given in specifications is maximum to which regulator should be set. Under certain operating conditions regulator may be set below 15 volts and still keep batteries charged. Frequent need for water in battery is an indication of excessive charging and

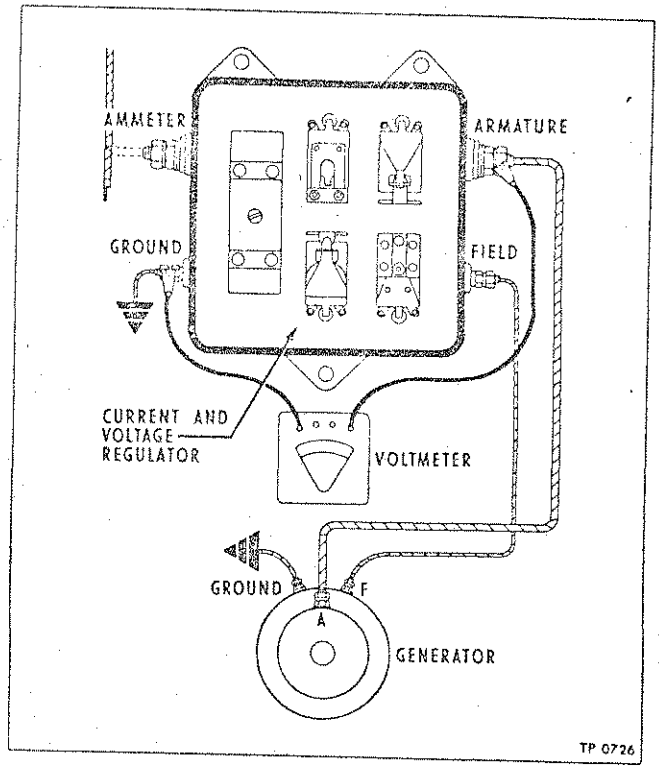


Figure 13—Meter Connections for Voltage Regulator Voltage Setting Check

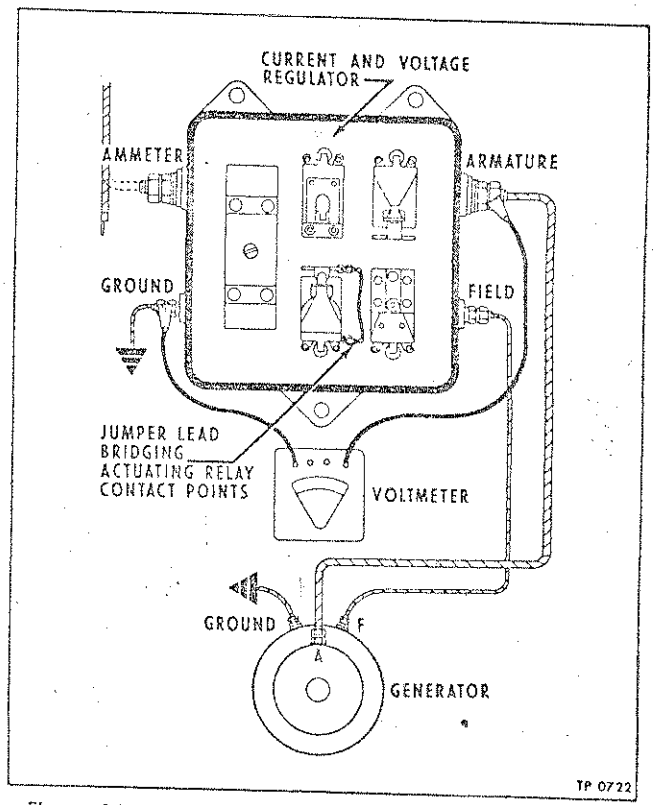


Figure 14—Meter Connections for Cut-out Solenoid Operating Voltage

REGULATOR

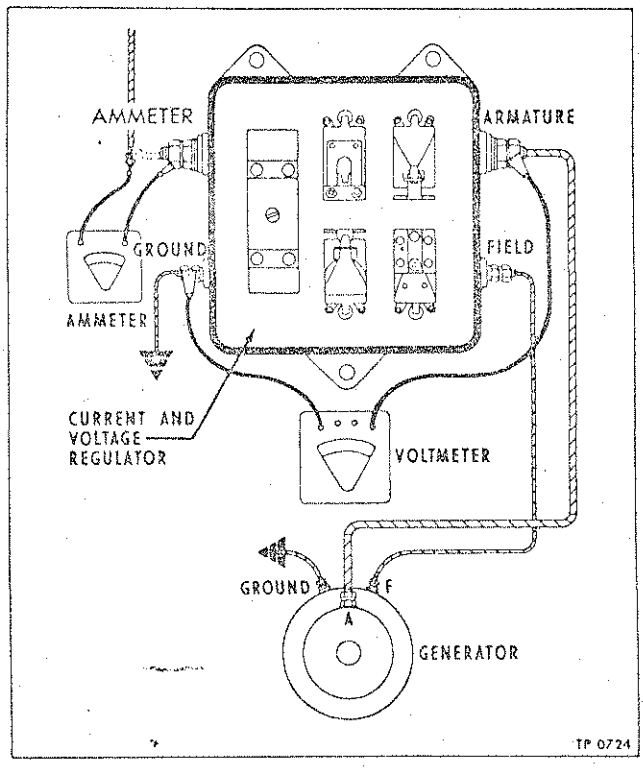


Figure 15—Meter Connections for Actuating Relay Closing Voltage Check

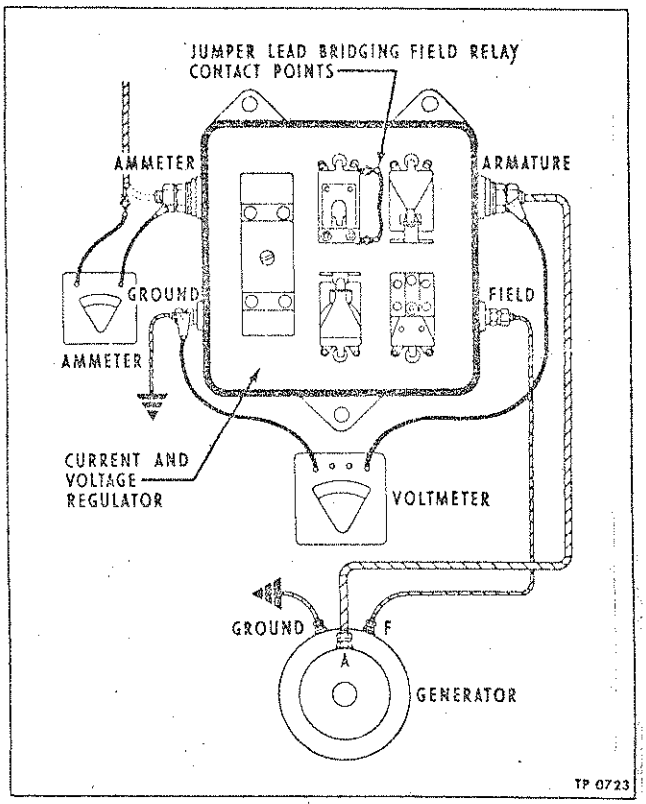


Figure 16—Meter Connections for Current Regulator Current Setting Check

reduction in regulator setting will prevent this.

CAUTION: NEVER SET VOLTAGE REGULATOR SETTING BELOW ACTUATING RELAY VOLTAGE SETTING. TO DO SO WILL PREVENT CUT-OUT SOLENOID FROM OPERATING AND WILL PREVENT BATTERIES FROM BEING CHARGED.

Cut-Out Solenoid Operating Voltage

1. Disconnect lead at regulator "ammeter" terminal (fig. 14).

2. Connect a jumper lead across actuating relay contact points so that points are short circuited (fig. 14).

3. Connect a test voltmeter between "armature" terminal and "ground" terminal on regulator (fig. 14).

4. Run generator and increase speed slowly, noting voltage necessary to close contact points. Allow generator speed to decrease and note voltage at which contact points open. Refer to "Specifications" later in this section, for opening and closing voltage settings. If unit does not operate within specified range, the solenoid plunger spring should be removed and tension increased or decreased to obtain the correct voltage setting.

Actuating Relay Operating Voltage

1. Connect a test voltmeter between "armature" and "ground" terminals (fig. 15).

2. Disconnect battery lead at "ammeter" terminal and connect a 120 ampere ammeter between "ammeter" terminal and battery lead (fig. 15).

3. Start generator and slowly increase speed, noting voltage necessary to operate the relay. Refer to "Specifications" later in this section for operating voltage.

4. To adjust, loosen lock screw and turn eccentric screw to change spiral spring tension. Increasing tension increases voltage setting, decreasing tension lowers voltage setting.

5. Tighten lock screw and again check setting by reducing generator speed then increasing to note voltage setting.

6. As generator speed is reduced note amperes of reverse current and voltage at which points open. Refer to "Specifications" later in this section for operating data.

Current Regulator Current Setting

1. Connect a test ammeter into circuit at regulator "ammeter" terminal, and bridge field relay contact points with a jumper lead to prevent it from operating (fig. 16).

2. Turn on lights or other electrical accessories to prevent high voltage. Operate generator at medium speed. When regulator has reached operating temperature, note current read-

ing. Refer to "Specifications" later in this section.

3. To adjust, loosen lock screw and turn eccentric screw to change spring tension. Increasing tension increases current setting, decreasing tension lowers setting.

4. After tightening the lock screw, check the current setting by stopping generator and then bringing it back to speed again.

HIGH POINTS ON FIVE UNIT REGULATOR PERFORMANCE AND CHECKS

1. Never close the cut-out solenoid contacts by hand with the regulator connected to the battery.

2. Never adjust the voltage regulator setting below the actuating relay setting.

3. Regulator settings must be made with the regulator at operating temperature (135° - 145°F.).

4. Be sure the battery to which the regulator is connected has the proper terminal grounded as stamped on the regulator model plate.

5. After making any regulator electrical adjustment, check the setting by stopping the generator and then bringing it back to speed.

6. Be sure the rubber gasket is in place in the regulator cover to prevent dust from entering the regulator.

7. The voltage regulator unit is precision set and in operation controls the action of the field relay.

8. The field relay inserts resistance into the generator field circuit as its points open to cause a lowering of the generator output in accordance with the condition of charge of the battery and the connected load.

9. The actuating relay is precision set and in operation actuates the cut-out solenoid.

10. The cut-out solenoid makes and breaks the circuit between the generator and the battery.

SPECIFICATIONS

Make	Delco-Remy
Model	005620
Generator (Model)	1117566
Field Relay*	
Air Gap	0.010"
Open Circuit Voltage	8
Voltage Regulator*	
Air Gap	0.018"-0.020"
Point Opening	0.005"-0.008"
Voltage Setting-Open Circuit (1275 R.P.M.)	14.6
Cut-Out Solenoid	
Point Opening	0.050"
Closing Voltage	9.0
Opening Voltage	4.0
Actuating Relay	
Air Gap	0.050"-0.060"
Point Opening	0.020"
Closing Voltage	13.5
Opening Voltage @ 7.0 Amps. (Reverse Current)	12.8
Current Regulator	
Point Opening	0.012"-0.015"
Current Setting-Amps. @ 13.0 Volts	120

*Be sure field relay is adjusted before attempting to adjust voltage regulator.

REGULATOR

SERVICE BULLETINS

Service Bulletins are issued, whenever required, supplementing information in this section. The information contained in these bulletins should be noted in the text and bulletin filed for future reference--make note of bulletin number in space below:

NOTES

Lighting System

Contents of This Section

Related Subjects in Other Sections

Circuits for all lights are shown on the Wiring Diagram in Wiring (Sec. 7A of this manual). Fuses for lighting circuits are also listed in that section, and in addition, fuses are listed in Operation (Sec. O of this manual).

IMPORTANT: All lights should be checked daily and necessary replacements made immediately. Bulb sizes are listed in "Specifications" at end of this section.

SWITCHES AND FUSES

Light switches for all exterior and interior lighting equipment except driver's light, engine compartment lights, stop lights, and tell-tale lights, are located in instrument panel in front of driver. Baggage compartment lights are controlled by a master switch on instrument panel and by individual switches in baggage compartment.

Fuse panel located on back of instrument panel is accessible by removing cover plate below instrument panel switches. Fuse panel contains fuses for all lighting equipment except engine compartment lights. Fuse for engine compartment lights is mounted in engine compartment.

EXTERIOR LIGHTING EQUIPMENT

HEADLIGHTS

Headlight (fig. 1) is double filament "Sealed Beam" type. The lens, reflector, and bulb constitute a complete unit and can be replaced only as such. If lens is cracked, bulb burned out, or reflector damaged, replace complete unit.

Switch marked "Head" controls headlights while foot dimmer switch in floor permits selection of either upper or lower beam. Tell-tale light on instrument panel marked "Hi-Beam" is illuminated when upper beam is used.

Proper Use of Headlights

Headlights are designed to provide adequate highway lighting for normal operating conditions. The headlights will provide safe lighting, providing they are aimed correctly, equipped with proper Sealed Beam units, lens are clean, and upper and lower beams are used correctly.

1. Upper Beam. High beam should be used only on unlighted roads when no approaching vehicles are near.

2. Lower Beam. Lower beam should always be used when approaching another vehicle. The depressed beam provides safer road visibility than upper beam under passing conditions, providing both vehicles use the depressed beam.

3. Headlight Lens. Dirt on lens absorbs a considerable amount of light. Clean lens with water and a good glass cleaner whenever dirty.

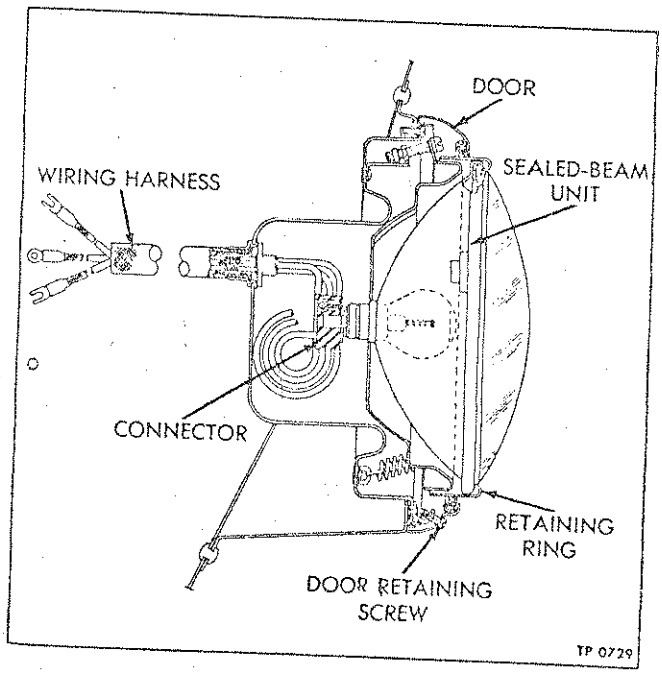


Figure 1—Headlight Assembly

LIGHTING SYSTEM

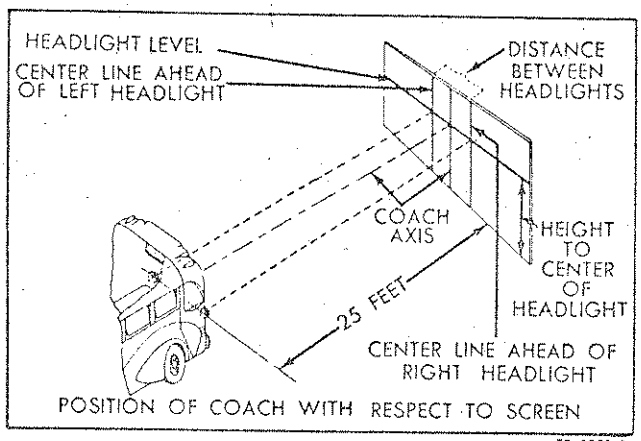


Figure 2—Headlight Aiming Chart

4. Headlight Wiring. For maximum illumination proper voltage must be obtained at the bulb. Discharged battery, loose or dirty electrical contacts in wiring system and poor ground connection all contribute to a decrease in voltage. Check wiring and connections regularly, make sure generator is charging sufficiently, and keep battery properly charged.

Sealed Beam Unit Replacement

Headlight sealed beam unit may be replaced in following manner:

1. Remove rim retaining screw and remove rim.
2. Remove three retaining screws.
3. Pull sealed beam unit out of light body, disconnecting wiring as unit is removed.
4. Insert prongs of new sealed beam unit into wiring plug, then position unit in light body.
5. Install sealed beam unit retaining ring and attach to light body with three screws.
6. Install door with clip engaging slot at top of light body. Install door retaining screw at bottom of door, tightening screw firmly.

Headlight Adjustment

Headlights must be aimed carefully and accurately to assure safe vehicle operation at night. Adjustments can be made quickly and accurately with a headlight tester, but if such equipment is not available, adjust lights as follows:

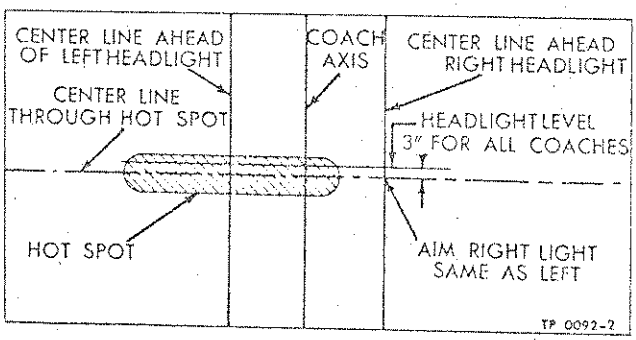


Figure 3—Headlight Beam Pattern

1. Position vehicle on level floor with headlights 25 feet from a vertical wall or door as shown in figure 2. Vehicle center line must be perpendicular to vertical surface.
2. Draw a horizontal line on vertical surface at height of light center as shown in figure 2. Locate a point on this horizontal line at which projected center line of chassis intersects. Measure distance between light centers and divide the distance equally on either side of center mark. Then draw a vertical line directly ahead of each light center as shown.
3. Switch on high or bright beam in headlights and cover one light while adjusting other.
4. Remove door retaining screw (fig. 1), and door for access to adjusting screws. Top screw provides vertical adjustment and side screw aims light horizontally.
5. Beam pattern should approximate that shown in figure 3. A distorted beam pattern is usually caused by a sprung reflector in which event sealed beam unit must be replaced.
6. After headlight is properly aligned, cover its beam and proceed in same manner as above with opposite light.

HEADLIGHT DIMMER SWITCH

Foot-operated headlight dimmer switch, mounted in driver's floor at left side, is attached to switch mounting plate with two bolts.

Switch requires no maintenance; however, switch may be replaced by removing two mounting bolts, after which switch is readily accessible from underneath front of vehicle.

When installing switch, connect wires to terminals before attaching switch to mounting bracket.

IMPORTANT: Brown wire with black and red check must be connected to terminal on switch marked "BAT;" Connect other two wires to remaining terminals; position of these wires with respect to terminals is not important.

FOG LIGHTS

Fog lights are mounted in recessed pockets in front end panels between headlights. A special bulb with a metal fog cap to prevent glare from direct rays, and an amber lens are identifying characteristics of this type of light.

"Fog" switch on instrument board energizes fog light circuit. With "Fog" switch turned on, lights can be turned off and on by foot-operated switch in floor ahead of driver's seat.

Light Bulb Replacement

1. Remove fog light door retaining screw, then remove door (fig. 4).
2. Remove three retaining ring screws, then remove retaining ring and lens.
3. Press in on bulb, at some time turning bulb counterclockwise to remove bulb.
4. Position new bulb in light with prongs engaged in holes in bulb flange. Due to prong spacing bulb can be installed in only one position.
5. Press bulb in firmly, turning bulb clockwise at the same time. Make sure all prongs are properly engaged.
6. Install lens, retaining ring, and three retaining ring screws.
7. Install door, engaging clip on door in slot at top of light body. Fasten door with retaining screw.

Fog Light Adjustment

Refer to "Headlight Adjustment." Fog lights are adjusted in same manner as headlights, however beam pattern differs from headlight pattern. Fog light "hot spot" is more concentrated around center line of light, and "cut-off" at top of beam is more sharply defined than on headlights.

MARKER LIGHTS

Front and rear combination marker and clearance lights are attached to body at roof corners. Light bulbs are accessible by removing two lens retainer screws, lens retainer, and lens.

Front Michigan marker lights, mounted on front roof panel above destination sign are same type as corner lights.

Rear Michigan marker lights are mounted on rear roof panel in center of coach. Bulbs are accessible by loosening clamp ring screw and nut, and then removing clamp ring and lens.

All marker lights are controlled by "Marker" switches on instrument board.

TAILLIGHTS

Taillights are mounted in housings attached to engine compartment side doors, as shown in figure 3 in Operation (Sec. O, of this manual).

Taillights are controlled by "Marker" switch on instrument board. Light bulbs are accessible for replacement by removing two screws which attach door to body of light, then removing door from body.

TARGET SIGN LIGHTS

Four light bulbs, illuminating target sign are controlled by "Marker" switch on instrument board.

Light bulbs can be replaced after removal of stop light in center of target sign. Target sign

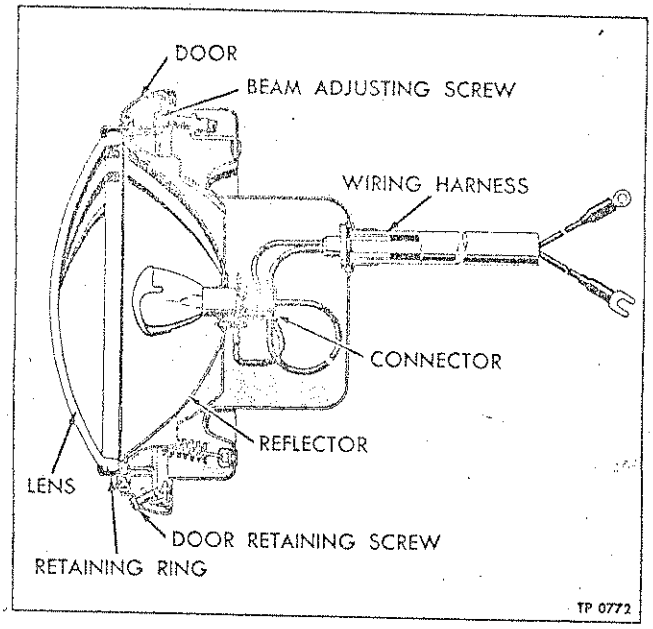


Figure 4—Fog Light Assembly

seal and insert are same type used for windshield, rear windows, etc. Directions for removal and installation of insert and seal are given under "Glass Replacement" in Body (Sec. 3 of this manual).

LICENSE PLATE LIGHT

License plate light, mounted at rear of vehicle directly over the rear license plate holder, is controlled by "Marker" switch on instrument panel.

Bulb is accessible for replacement by removing light cover, cap, and glass.

DESTINATION SIGN LIGHTS

Three lights for illumination of front destination sign are mounted inside destination sign door.

Bulbs are accessible for replacement by opening destination sign door.

Destination sign lights are controlled by "Sign" switch on instrument panel.

STOP LIGHTS

Stop lights are mounted in housing attached to engine compartment side doors and in rear target sign.

Stop light bulb is accessible for replacement after removal of light door, which is attached to body of light with two screws.

Stop Light Switch

Stop lights are controlled by an air-operated switch (fig. 5) connected in the brake system. Relative location of switch is shown in Air Brakes (Sec. 4B of this manual), while electrical circuit is shown in Wiring (Sec. 7A of this manual).

Circuit Continuity

Connect one prod of test light to No. 1 terminal of relay and other prod to ground. Close both sets of relay points manually. If test lamp fails to light, relay circuit is open and location of open circuit can be found by performing tests as given under "Open Circuit Tests."

Open Circuit Tests

Connect one prod of test lamp to No. 5 terminal of relay and other prod to ground. If test lamp fails to light, relay coil is open circuited. Repeat proceedure with test light connected to No. 4 terminal of relay.

DIRECTIONAL SIGNAL LIGHTS

Directional signal lights, mounted at front corners of vehicle, and in housings attached to engine compartment side doors, are used to signal to drivers of other vehicles, the direction in which vehicle will turn. Electrical circuit is shown in Wiring (Sec. 7A of this manual).

Signal light bulbs are accessible for replacement after removal of lens and rim which are attached to light body with two screws.

Lights are controlled by switch in bracket attached to steering column. Circuit breaker (flasher) causes signal lights to flash off and on automatically. Tell-tale light in switch bracket flashes in synchronism with directional lights.

Tell-tale light bulb is accessible for replacement by pulling bulb and socket free from holder from underneath bracket. Bulb can then be easily removed from socket.

SPOT LIGHT

Spot light is mounted through front corner post at left of windshield. Beam is directed by a handle, which also contains light switch, from inside vehicle.

Light bulb is accessible by removing lens clamp ring and lens.

INTERIOR LIGHTING EQUIPMENT

INSTRUMENT PANEL LIGHTS

Instruments in instrument panel are illuminated by lights controlled by "Marker" switch in instrument panel.

Light bulbs are accessible by pulling bulb socket free from back of instrument panel. Bulb then can be easily removed from socket. After replacing bulb, press socket firmly into holder in back of socket.

STEPWELL LIGHTS

Front entrance door stepwell is illuminated by two lights, one mounted in tool compartment door and one mounted in vehicle door. Light circuit is energized with "Step" switch turned on, circuit being completed by a switch actuated by door operating mechanism. Consequently, lights operate only with "Step" switch turned on and with front entrance door opened. Lights are designed to illuminate both the lower step of vehicle, as well as the ground below the step for the safety and convenience of passengers entering and leaving vehicle.

Bulbs may be replaced, by removing socket in back of lamp on tool compartment door. Bulb in door is exposed and can be readily replaced.

Stepwell Light Switch

Switch is actuated by stud which is retained on door operating rod by a clamp. When door is opened, stud releases pressure on switch plunger thus closing step light circuit. When door is closed, stud forces switch plunger into switch body and circuit is opened.

Whenever switch is replaced or door operating mechanism is adjusted, switch operating mechanism should be checked and adjusted if necessary.

Clamp and stud assembly is accessible for adjustment through safety equipment compartment door. Adjustment is made as follows:

1. Open compartment door and observe movement of clamp and stud assembly as vehicle door is opened and closed.
2. Loosen clamp bolt, which retains clamp on door operating rod, and move clamp and stud on rod until stud releases light switch plunger just before vehicle door is completely opened.
3. Make sure stud contacts switch plunger firmly when vehicle door is closed, then tighten clamp bolt to lock adjustment.

NIGHT LIGHT

Night light is a low candlepower, blue bulb contained in the second from rear indirect dome light (both sides), connected to a separate circuit controlled by "Sign" switch in instrument board.

DOME LIGHTS

Dome lights are flush mounted on top of package rack outer moulding and are controlled by "Indirect" switches on instrument panel.

Remove two screws from lens retainer, then remove lens and retainer for access to light bulbs.

READING LIGHTS

Reading lights are flush mounted on underside of racks and in roof trim at rear of coach. When switch marked "Rear Marker" on instrument panel is turned on, individual switches at each reading light permit passenger control of lights.

Each light has two switches and three bulbs, except rear center light which has one bulb. Bulbs are accessible for replacement by removing lens and lens retainer.

LIGHTING SYSTEM

DRIVER'S LIGHT

Driver's light, mounted on trim panel above driver's window is controlled by driver's light switch. Refer to Wiring (Sec. 7A of this manual) for Wiring Diagram.

Bulb is accessible for replacement by removing lens and retaining rim which are attached with three screws.

TELL-TALE LIGHTS

Tell-tale lights are provided to warn driver of certain conditions, as follows:

1. "Stop" tell-tale is illuminated when brakes are applied. If tell-tale fails to light with brake application, check stop light, tell-tale bulbs, circuit, relay, and stop light switch to determine cause.
2. "Door" tell-tale, which lights when emergency door is not properly closed, is operated by a switch at emergency door lock.
3. "Hi-Beam" tell-tale is illuminated when country or upper headlight beam is used.
4. "Low-Air" tell-tale lights when pressure in air system becomes too low to operate brakes efficiently.
5. "Low Oil Pressure" tell-tale is illuminated when engine oil pressure falls below safe minimum operating pressure.
6. "Hot Engine" tell-tale lights when engine temperature rises beyond a safe operating temperature.

Tell-tale bulbs are accessible for replacement by pulling bulb and socket free from back of panel. Bulb then can be easily removed from socket. After replacing bulb, press bulb and socket firmly into holder in back of panel.

BAGGAGE COMPARTMENT LIGHTS

Baggage compartments are illuminated by six lights controlled by switch marked "Baggage" on instrument panel, one light being mounted at each door. Each light is controlled by a separate switch mounted in such manner that opening and closing compartment door automatically turns switch on and off, when "Baggage" switch is on.

Bulbs are accessible for replacement by removing lens retainer, which is attached with three screws.

ENGINE COMPARTMENT LIGHTS

Power plant units are illuminated by two lights controlled by a switch in the engine compartment control box inside right rear closure door.

Bulbs are readily accessible for replacement.

SPECIFICATIONS

All light bulbs listed below are of 12-16 volt rating.

UNIT	CONTACT	C.P.	TRADE NO.
Headlights - Sealed Beam Unit			4430
Hi-Beam		45 Watts	
Low-Beam		35 Watts	
Fog Lights	SC	32	1011
Marker Lights	DC	3	68
Rear Michigan Marker Lights	DC	3	68
Taillight	SC	3	67
Target Sign Lights	DC	3	68
License Plate Light	SC	3	67
Destination Sign Lights	DC	6	90
Stop Lights	SC	15	93
Directional Signal Lights	SC	21	1141
Instrument Panel Lights	SC	3	67
Step Light (Door)	DC	21	1142
Step Light (Stepwell)	SC	21	1141
Night Light	SC	3	67 (Blue)
Dome Lights	SC	15	93
Reading Lights	SC	15	93
General Lighting Light	SC	6	89
Driver's Light	SC	15	93
Baggage Compartment Light	DC	6	90
Engine Compartment Light	SC	15	93
Tell-tale Lights	DC	3	68

Stop Light Relay

Make	Delco-Remy
Model	1116849
Air Gap (Points Closed)	0.014"
Point Opening	0.015" - 0.025"
Armature Attracted to Core (Amps.)	
Points Open	1.1
Points Closed	1.6

Engine Tune-up

Contents of This Section

Related Subjects in Other Sections

Refer to Diesel Engine Maintenance Manual Form X-4517

Results obtained from an engine tune-up may be unsatisfactory if a "hit and miss" method is used instead of a systematic approach to the job; therefore, the logical solution is a complete check-up following the cycle in the accompanying illustration and carrying out each step as directed below.

NOTE: Before tune-up procedure is started it is important that air cleaner is serviced as shown in its respective section of this manual, also crankcase breather tube and air box drains must be clean and unobstructed. Air box drains may be cleaned with compressed air.

CAUTION: Remove or at least loosen an air box hand hole cover, else blower or end plate gaskets may be damaged by excessive air pressure.

Reference should be made to "Trouble Shooting" (Sec. 17, page 14 of Diesel Engine Maintenance Manual Form X-4517) for engine operating trouble symptoms and causes.

COMPRESSION TEST

Compression test is beneficial in determining the need of internal repairs before tune-up procedures are accomplished. This test will indicate condition of pistons, rings, and valve mechanism.

For instructions on how to perform compression test, refer to Diesel Engine Maintenance Manual form X-4517, section 17, page 15.

TUNE-UP SEQUENCE (Refer to Fig. 1)

Following is sequence in which tune-up operations MUST be performed.

No detail instructions are given here, but rather reference is made to the Diesel Engine Maintenance Manual, form X-4517.

1. Lash exhaust valves (Sec. 11, page 2).

2. Set injector timing (Sec. 15, page 12).

3. Set governor spring plunger gap (Sec. 15, page 14).

4. Adjust injector rack control levers (Sec. 15, page 15).

5. Adjust engine idling speed (Sec. 16, page 14).

6. Adjust governor buffer spring screw (Sec. 16, page 14).

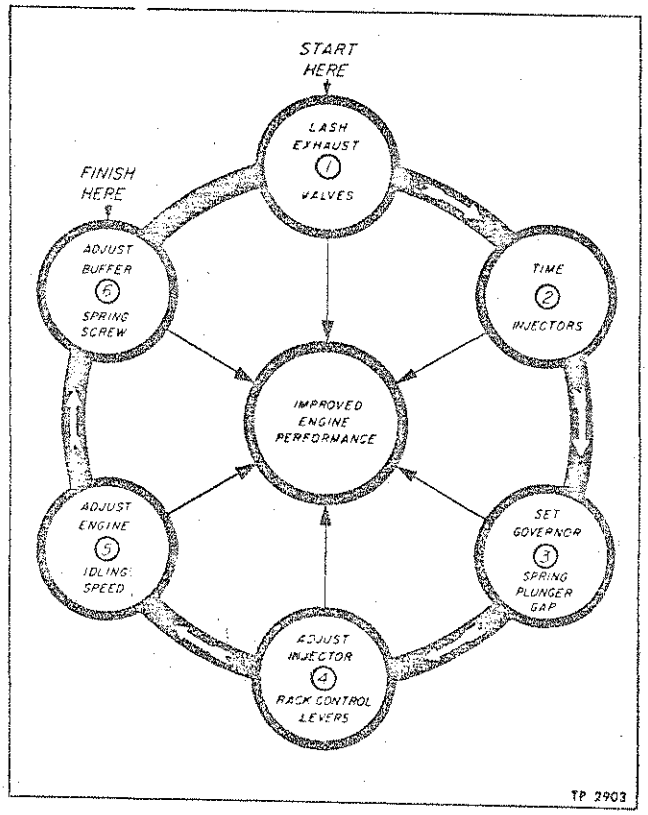


Figure 1—Engine Tune-up Chart

ENGINE TUNE-UP

SERVICE BULLETINS

Service Bulletins are issued, whenever required, supplementing information in this section. The information contained in these bulletins should be noted in the test and bulletin filed for future reference -- make note of bulletin numbers in space below:

NOTES

Diesel Engine

Contents of This Section

Related Subjects in Other Sections

Refer to Diesel Engine Maintenance Manual (Form X-4517)

Diesel engine used in vehicles covered by this manual is the six cylinder, two cycle, GM Series 71. Refer to "Specifications" at end of this section for further data.

Description, operating instructions, engine tune-up, trouble shooting, maintenance, and repair for this engine are contained in a separate maintenance manual for Series 71 Diesel engine (form No. X-4517).

Certain instructions such as operation, engine tune-up adjustments, etc., as well as accessories peculiar to these vehicles are covered in their respective sections within this manual. Reference should be made to the respective sections of this manual before referring to the Diesel manual.

OIL PRESSURE GAUGE

Oil pressure gauge system consists of two electrically connected units; an engine sending unit mounted in engine pressure lubrication system and a registering gauge mounted in instrument panel. Oil pressure gauge system is interconnected with control switch so that system is inoperative when switch is in "off" position. Refer to wiring diagrams in Wiring (Sec. 7A of this manual) for electrical circuit.

TESTS

If oil pressure gauge does not operate, or shows apparent false readings, with control switch turned on, check system as follows:

1. Check No. 2 fuse to see if it is burned out.
2. If not, disconnect wire at engine unit terminal.
3. Connect one end of a 1.5 candlepower 12 volt test lamp to battery terminal on starter solenoid. Touch other lead to body of engine sending unit. If bulb lights, unit is properly grounded. If bulb does not light, check for presence of sealing compound around threads of unit. Remove compound and repeat test.
4. Remove test lamp lead from body of unit, and touch lead to terminal on unit. If bulb lights, engine unit is shorted and must be replaced.
5. Remove test light and reconnect wire from gauge unit to engine unit terminal.
6. Test wiring and units for current flow. Use test lamp as follows:

   a. Connect one wire of test light to terminal on engine unit to which wire from control switch is connected. Connect other wire of test light to ground. If bulb fails to light, check wiring for open circuit.

   b. Connect one wire of test lamp to gauge terminal to which engine unit is connected, and other test light wire to ground. Replace engine unit if bulb fails to light.

   c. Connect test lamp between other gauge terminal and ground. Replace gauge if bulb does not light.

7. If system still fails to function, trouble must be in the actuating elements of either engine or gauge units or both and condition can be corrected by installing new unit in either or both of two positions.
8. Do not attempt to repair either engine or gauge units. When installing new engine unit, do not use thread sealing compound on threads as this will increase electrical resistance of unit and cause faulty reading on gauge.

LUBRICATING OIL STRAINER AND FILTER

Diesel engine used in vehicles covered by this book are equipped with a cleanable type oil - strainer and a replaceable, non-cleanable element - type filter.

OIL STRAINER

The oil strainer, illustrated in figure 1, incorporates a cleanable type element through which

DIESEL ENGINE

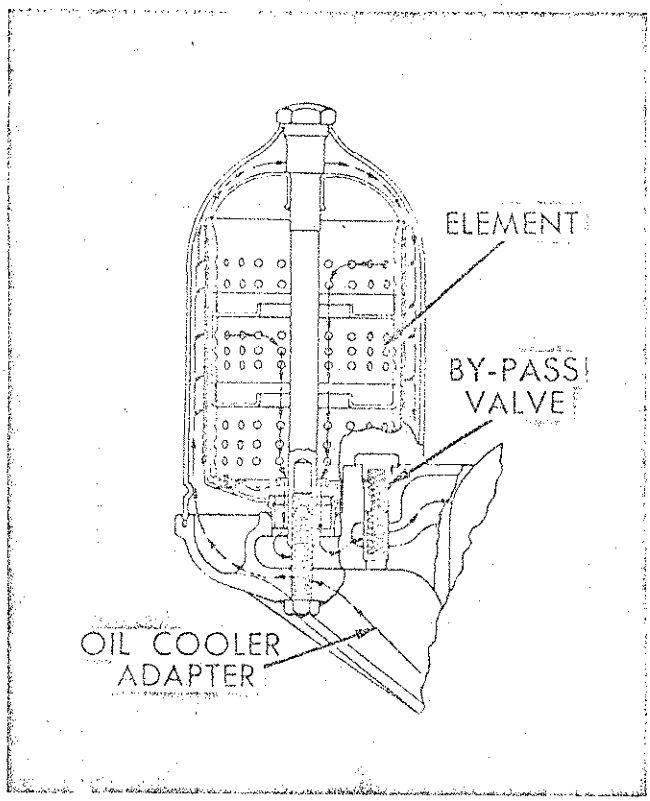


Figure 1—Sectional View of Oil Strainer

all the oil leaving the oil pump passes. Strainer removes all particles larger than .005" in diameter.

Strainer element must be thorough cleaned at each oil change. If strainer is not cleaned, it will eventually become restricted or even clogged; then flow of oil is by-passed around strainer and oil cooler as well. Under these conditions oil will not be strained or cooled and serious damage to engine may result.

CLEANING OIL STRAINER

1. Remove strainer drain plug and allow oil to drain from strainer.
2. Unscrew oil strainer through-bolt then lift off strainer housing and element.
3. Wash inner and outer surfaces of element in clean fuel oil, or other suitable cleaning fluid, using a fine bristle brush. Do not use a wire brush. Be sure element is thoroughly clean.
4. Wash other strainer parts as well, making certain all parts of the strainer are clean before reassembling unit, also that gaskets at either end of housing are in place and in good condition.

OIL FILTER

The oil filter, illustrated in figure 2, incorporates two replaceable, non-cleanable filtering elements through which only a metered portion of the circulated oil passes. This filter removes abrasive matter, sludge, wax, and other substances detrimental to the engine. Filter elements must be discarded and replaced with new elements at each oil change; otherwise the new oil will become contaminated, and eventually flow of oil through filter will cease resulting in possible serious damage to engine.

CLEANING OIL FILTER

1. Remove filter drain plug and allow oil to drain from filter.
2. Unscrew oil filter through bolt then lift of filter housing and elements. Discard elements.
3. Wash filter parts in clean fuel oil or other suitable cleaning fluid.
4. Install a new element and make certain all parts of the filter are clean before reassembling unit, also that gaskets at either end of housing are in place and in good condition.

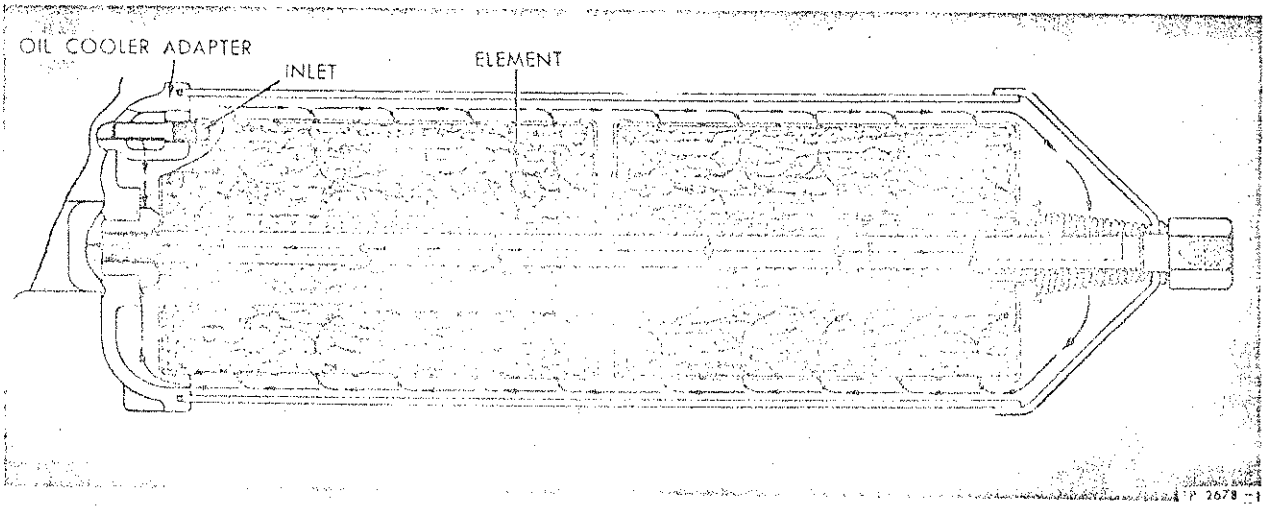


Figure 2—Sectional View of Oil Filter

SOLENOID

A solenoid is an electrical device used to operate a unit to which the solenoid is connected mechanically.

When solenoid is energized, by means of a remote control switch, solenoid plunger is pulled into solenoid coils, thereby operating the unit to which solenoid plunger is attached.

ENGINE STOP SOLENOID

Engine stop solenoid is mounted on engine governor and is connected to governor cam. Solenoid, when energized by means of engine stop switch at instrument panel (also in engine compartment), moves governor cam allowing governor to move injectors into "No-Fuel" position.

MAINTENANCE

Keep all terminals clean and tight. Always check action of solenoid if it has been removed and reinstalled. If solenoid fails to function, check switch and wiring before working on solenoid.

Only test to make on solenoid is to check pull of solenoid coils with suitable equipment. Test specifications are li ted under "Specifications" at end of this section.

EMERGENCY STOP SOLENOID

Emergency stop solenoid, mounted on blower intake, is used to release a valve to shut off air supply to engine, thereby stopping the engine. Solenoid is energized by an emergency stop switch at instrument panel, as explained in "Operation" section of this manual. Energizing solenoid pulls solenoid plunger out of notch in valve shaft, thereby permitting spring tension to close valve.

NOTE: Whenever valve is released, engine cannot be started again until valve is reset by hand.

MAINTENANCE

Keep all terminals clean and tight. Always check action of solenoid if it has been removed and reinstalled. If solenoid fails to function, check switch and wiring before working on solenoid.

Only test to make on solenoid is to check pull of solenoid coils with suitable equipment. Test specifications are listed under "Specifications" at end of this section.

ELECTRICAL TACHOMETER

Tachometer is comprised of two electrical units interconnected by an electrical cable. The drive unit (fig. 3) is mounted in the engine compartment of the vehicle and is driven by a short flexible shaft from the engine blower drive shaft. A four-wire conductor cable extends from the drive unit to the motor unit (fig. 4) which is mounted at the instrument panel. Motor unit consists of an electric motor and a mechanical tachometer head.

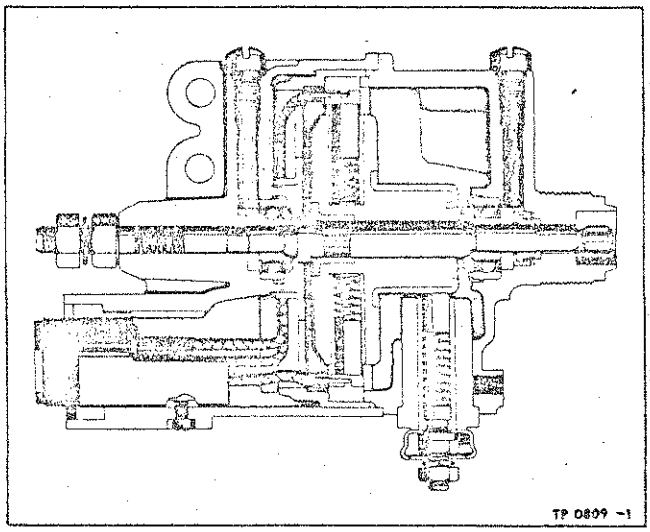


Figure 3—Engine Tachometer Drive Unit

Drive unit uses 12 volt current taken from vehicle electrical system and is interconnected with control switch so that tachometer is inoperative when control switch is in "OFF" position as shown in figure 5. This current is divided in the drive unit by means of a mechanical driven rotor having two brushes which run against a resistor ring. These electrical impulses are transmitted through the four-wire cable to the motor unit where two pair of coils cause a magnetic rotor to rotate at exactly the same speed as the mechanical driven rotor in the drive unit. Since the magnetic rotor is coupled to tachometer head, rotation is transformed to a reading on face of calibrated tachometer head. Thus, a synchronized electrical drive is accomplished.

TESTING

When testing tachometer electrical, units, use a fully charged 12 volt battery. Variation of plus or minus one volt is permissible. The maximum current consumption should not exceed 3.8 amps. when drive unit is stationary; 1.5 amps. when running.

Jam nut, located at point where the four-wire cable conduit fastens to connector plugs, should always be kept tight so that connector plug body grips cable insulation and prevents conduit coming loose from connector plugs due to rough handling.

DIESEL ENGINE

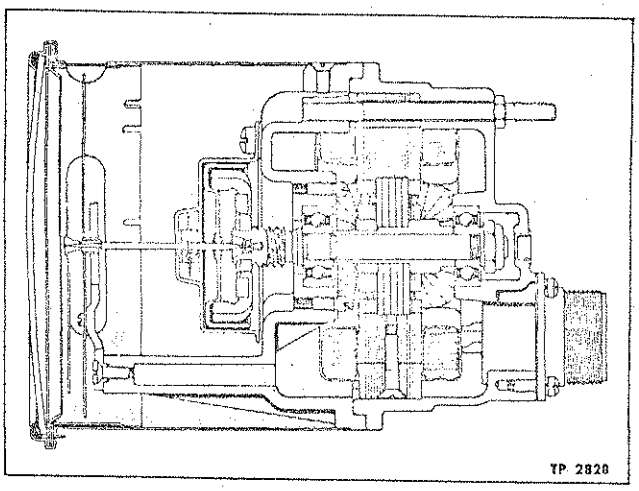


Figure 4—Engine Tachometer Motor Unit

If tachometer fails to function test electric tachometer with test lamp number 1568147 as follows:

1. Check test lamp bulbs with battery to be sure they are not burned out. Check 6 amp. fuse in wire leading from vehicle electrical system to drive unit, refer to Wiring diagram figure 5, to be sure it is not burned out.

2. Pull four-contact plug out of drive unit and insert plug on end of test lamp cable in its place.

3. Turn control switch on to energize drive unit.

4. Disconnect flexible drive shaft at engine blower drive shaft, and turn flexible drive shaft slowly by hand. If test lamp bulbs glow alternately bright and dim, the drive unit is functioning properly.

5. Remove test lamp cable plug from drive unit and reconnect four-wire cable.

6. Disconnect cable plug from motor unit and connect to test lamp cable using double end male adapter chained to end of cable.

7. Again turn flexible drive shaft slowly by hand. If test lamp bulbs glow alternately bright and dim, wiring between drive unit and motor unit is good and trouble should be in motor unit.

8. If test lamp bulbs fail to glow when connected to drive unit, check feed and ground connections at drive unit for tight connections, also check for broken flexible drive shaft.

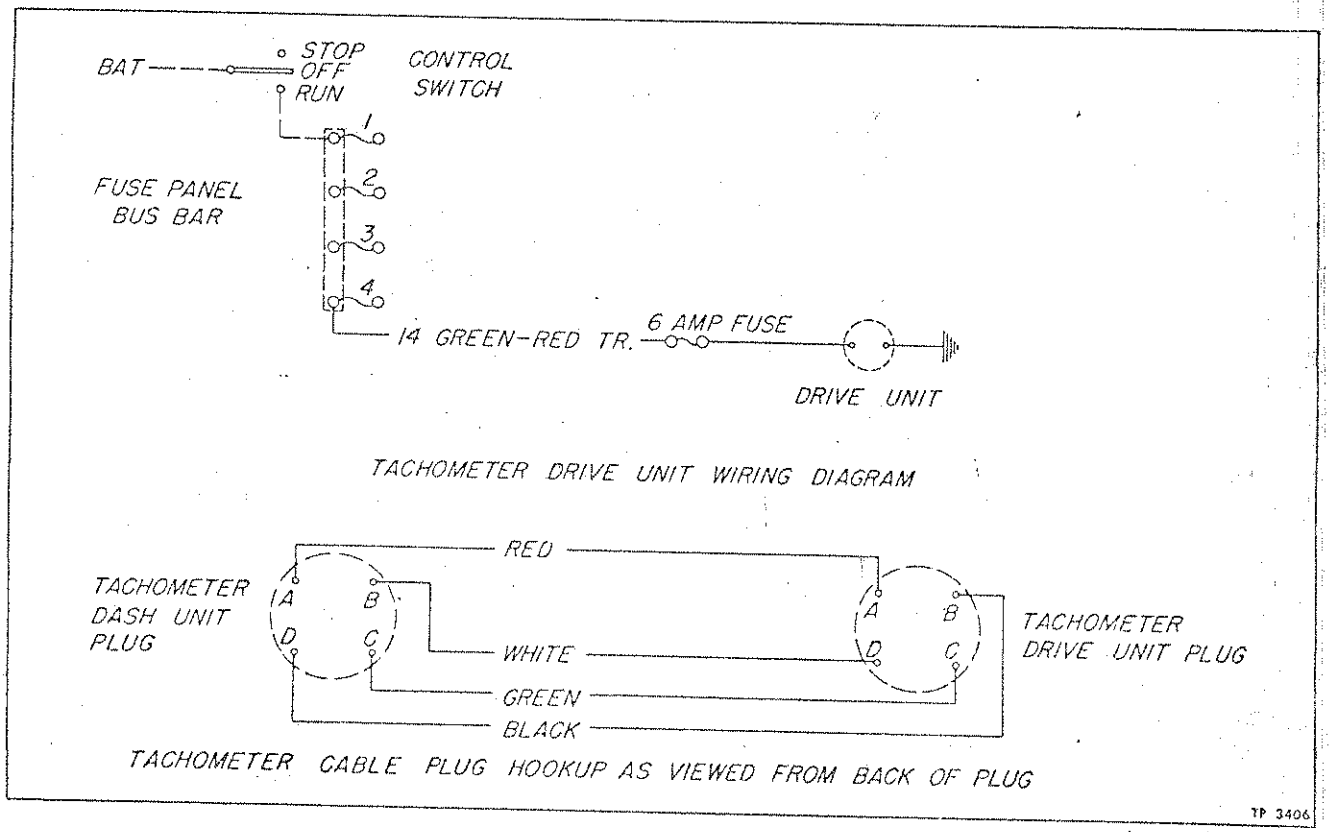


Figure 5—Engine Tachometer Wiring Diagram

9. If test lamp bulbs glow when connected to drive unit but not when connected at front of four-wire cable, make careful check of cable for broken wires or loose connections where wires attach to sockets.

Following above procedure will determine whether trouble lies in drive unit, four-wire cable, or in motor unit.

NOTE: If tachometer calibration is not satisfactory, tachometer head may be recalibrated by an authorized United Motors Service Station. Tachometer calibration descrepancies have no connection with the electric drive unit providing the tachometer head and motor unit are not binding. Binding is indicated by excessive pointer fluctuations.

MOTO-GARD AND TELL-TALE ALARM SYSTEM

Moto-Gard and tell-tale alarm system comprises a group of automatic electrical devices which prevent damage to engine due to loss of oil pressure or excessive coolant temperature by stopping the engine when either of these conditions occur. Operation of this system is explained in Operation (Sec. O of this manual). Maintenance and repair of units included in Wiring and Miscellaneous Electrical (Sec. 7A of this manual).

SPECIFICATIONS

ENGINE DATA

Model	671LA35
Bore	4-1/4"
Stroke	5"
Total Displacement - Cu. In.	425.31
Rotation	Counterclockwise
Firing Order	1-4-2-6-3-5

ENGINE STOP SOLENOID

Make	Delco-Remy
Model	991424
Max. Volts to Close @ 70°F.	4.0
Current Consumption @ 12 Volts (Amps.)	12.0-13.0

EMERGENCY STOP SOLENOID

Make	Delco-Remy
Model	001424
Max. Volts to Close @ 70°F.	4.0
Current Consumption @ 12 Volts	12.0-13.0

OIL PRESSURE GAUGE - ON INSTRUMENT PANEL

Make	King Seeley
Type	
Gauge Unit	7999-2
Engine Unit	41500
Voltage	6
Range	0-80 Lbs.

ENGINE TACHOMETER

Make	AC
Model	
Drive Unit	1567678
Motor Unit	1536658

SPECIAL TOOLS

Reference is made to special tools in this section. These tools, or their equivalent, are necessary and are recommended to more readily and efficiently accomplish certain service operations. The tools, however, are not supplied by GMC Truck & Coach Division. Names and addresses of vendors or manufacturers are shown as a reference, and since such vendors are the suppliers of these tools, information regarding availability, price, etc., should be obtained directly from them.

Tool No.	Tool Name
1568147	Electric Speedometer Test Light

Vendor	Address
AC Spark Plug Division	Flint, Michigan

DIESEL ENGINE

SERVICE BULLETINS

Service Bulletins are issued, whenever required, supplementing information in this section. The information contained in these bulletins should be noted in the text and bulletin filed for future reference - Make note of bulletin number in space below:

NOTES

Engine Mounting

Contents of This Section

Related Subjects in Other Sections

ENGINE MOUNTING

Diesel power plant, including engine, clutch and transmission is mounted transversely at the rear of coach, as shown in figure 1. Power plant and accessories are accessible for minor service operations through rear and right hand compartment doors. Transmission may also be removed as a unit, independent of engine, to permit service operations on clutch or transmission. Refer to (Sec's. 5 and 17 of this manual) for procedures of the above two units.

Engine compartment switch panel, accessible through right hand rear compartment door, contains starter button, engine stop button, starter circuit cut-out switch and engine compartment light switch. Always shut off starter circuit cut-out switch before working on engine. This prevents accidental starting of engine with starter button, while working on engine.

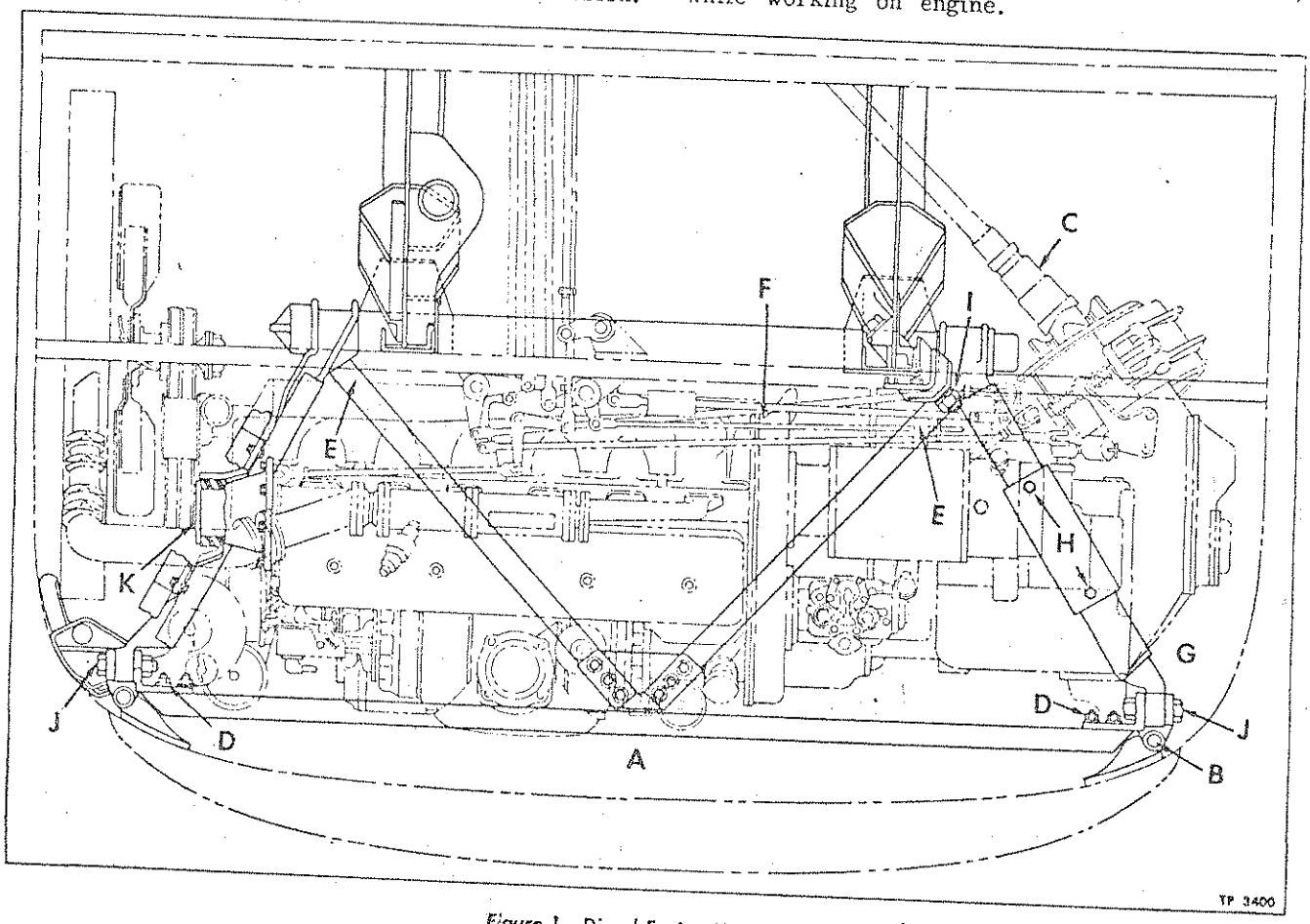


Figure 1—Diesel Engine Mounting

ENGINE MOUNTING

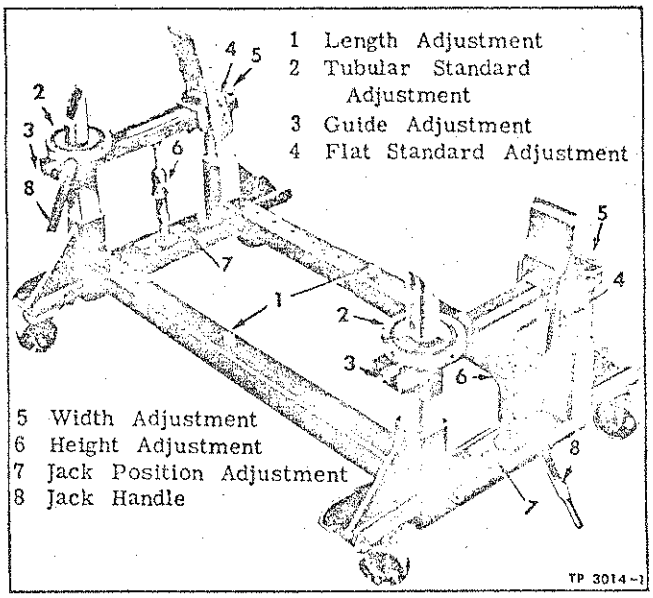


Figure 2—Power Plant Dolly

REMOVING POWER PLANT

Power plant including transmission may be removed from vehicle in following manner: Procedures outlined are in sequence and should be followed in order. Refer to figure 1.

NOTE: Before proceeding with operations as listed, disconnect both battery leads.

1. Unlock right and left hand and center rear doors and transmission inspection door.
2. Shut off engine compartment starter circuit cut-off switch.
3. Remove center rear door to bumper bolts (A). Raise center door and provide a suitable means of holding door fully opened.
4. Remove bumper right hand pin (B) and swing bumper outward away from engine.
5. Unlock engine pan spring at left hand corner, remove bolts and clips at forward edge of pan, and remove pan.
6. Drain cooling system. Two drain cocks must be opened; one at water pump and one under forward radiator water outlet line.
7. Disconnect oil reservoir, oil line at engine balance weight cover, then remove oil reservoir from engine front mounting bracket.
8. Disconnect heater pipes between engine and bulkhead; cooling system between engine and radiator; air intake system between blower and manifold, also generator; compressed air system as necessary; electrical system; exhaust system; hand brake, transmission, clutch, and accelerator control rods; fuel lines and speedometer cable; tachometer cable if used.
9. Unscrew propeller shaft slip joint (C). When engine is removed propeller shaft will separate at slip joint.
10. Remove bumper channel bolts (D) and diagonal brace bolts (E). Remove channel and braces as an assembly.
11. Place special dolly (fig. 2) under engine and raise engine sufficiently to relieve pressure on mounting bolts.
12. Disconnect engine strut rod eye at strut rod bracket (F) on engine.
13. Remove transmission to insulator bolts, (G) at right hand corner strut.
14. Remove transmission to engine support bolts (H) at engine right hand support. Also battery ground strap.
15. Remove transmission insulator to frame bolt nut (I), at bulkhead side of transmission.
16. Unhook and drop transmission dust pan.
17. Remove right and left hand engine support member to right and left hand strut bolt (J) and allow support member to swing down.
18. Remove right hand strut to body frame bolt and remove strut.
19. Remove bolts (K), attaching engine front support insulator to front support.
20. Recheck carefully to be sure that all apparatus from engine to chassis has been disconnected, then withdraw engine through rear of vehicle.

SPECIAL TOOLS

Reference is made to special tools in this section. These tools, or their equivalent, are necessary and are recommended to more readily and efficiently accomplish certain service operations. The tools, however, are not supplied by GMC Truck & Coach Division. Names and addresses of vendors or manufacturers are shown as a reference, and since such vendors are the suppliers of these tools, information regarding availability, price, etc., should be obtained directly from them.

Tool No!	Name	Vendor Code
CS-1421	Engine Dolly	CS
CS-1926	Engine Overhaul Stand	CS

Code	Vendors Name	Address
CS	Curtiss Smith Mfg. Co.	Pottstown, Pa.

Fuel System

Contents of This Section

Related Subjects in Other Sections

FUEL SYSTEM

Description and maintenance of the Diesel fuel injector system, fuel oil pump, fuel oil manifolds, and governor are contained in separate maintenance manual for GM Series 71 Diesel Engine.

FUEL OIL SYSTEM MAINTENANCE

It is important that fuel oil is clean and free from water to assure efficient engine operation. When storing and dispensing fuel oils, it should be handled as described under "Fuel Oil Storage and Handling" later in this section.

FUEL OIL FILTERS

Two fuel oil filters, mounted to a common bracket on the engine (fig. 1), are provided to keep the fuel oil clean and free from water as it enters the injectors. Two small filters are also provided in each injector

The primary or lower of the two fuel oil filters is a cleanable (edge-type strainer) filter, and is designed to remove the larger particles of solid foreign matter and the water which may accumulate.

The secondary or upper filter is a removable element (absorption) type, and is designed to remove all of the solid foreign matter that may have passed through the edge type strainer.

CARE OF FUEL OIL FILTERS

In order for these filters to clean the fuel oil it is highly important that they are given proper care. Service in the following manner:

Primary Filter (Cleanable Type)

Primary filter (fig. 1) must be drained frequently because if water is present in the fuel it is most likely to accumulate in the filter. No definite draining periods can be given here, inasmuch as the necessity for draining depends upon the cleanliness of the fuel put into the fuel tank. It is recommended however, that a small amount of fuel oil be drained from this filter daily, noting the water content (if any), then from this experience definite draining periods may be established. Drain filter by opening drain cock at bottom of filter. If water in any amount is regularly found in this filter, it is an indication that something is wrong in the method of handling and storing of the fuel oil and a thorough investigation should be made to remove the trouble; then the fuel tank, lines and both filters drained and cleaned. The only water that will normally accumulate in the fuel system is from condensation in the fuel tank which will be very little if tank is kept as near full as possible.

Cleaning Primary Filter

In addition to periodic draining as described in preceding paragraph filter should be thoroughly cleaned every 5000 miles as follows:

1. Open drain cock at bottom of filter and allow filter to drain.
2. Unscrew through bolt (at bottom of filter), withdraw housing and edge type filter element.
3. Wash all filter parts, including strainer element, in a suitable cleaning solvent. Be sure all particles are removed from between disk of element. Use air if necessary.
4. Inspect filter housing gasket, element gasket, and through bolt gasket; replace if not in good condition.

FUEL SYSTEM

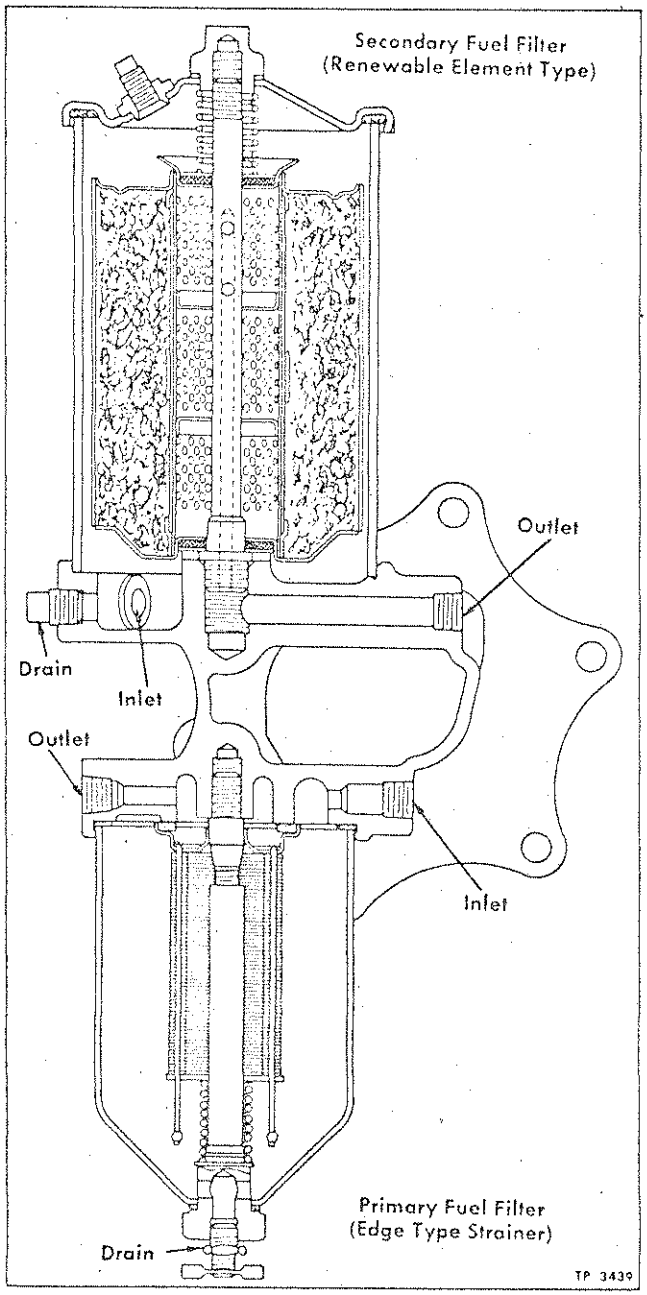


Figure 1—Fuel Filter Installation

5. Reassemble filter and inspect carefully for leaks. Be sure drain cock is closed tightly.

Secondary Filter Renewable Element Type

It is recommended that secondary filter (fig. 1) be drained at same intervals as primary filter. Refer to "Primary Filter" in previous paragraph for intervals.

In addition, to draining the following check should be made at intervals of 1500 to 2000 miles to determine the condition of the element. This check can be made by removing the pipe on the outlet side of the filter and installing a pressure gauge connected to a "tee." Start engine and note pressure on gauge. When the pressure reading is reduced to 15 lbs. at 2000 rpm, the element should be removed and replaced. Do not open the filter except at time of element replacement. Replacement usually will be required every 10,000 miles or 500 hours. DO NOT ATTEMPT TO REMOVE AND CLEAN FILTER ELEMENT.

Replacing Secondary Filter Element

If periodic check, as described in previous paragraph, indicates filter element should be changed, proceed in the following manner:

1. Remove drain plug from filter housing and allow filter to drain.
2. Loosen cover nut, then lift cover and gasket from filter housing.
3. Lift element from filter housing and discard element.
4. Wash all filter parts with a suitable solvent.
5. Install new element in housing and install cover, using a new gasket between cover and housing. Tighten cover nut. Be sure drain plug is installed tightly.
6. CAUTION: After element has been replaced as instructed above, loosen, but do not remove, the square headed plug at top of filter for air vent. Loosen it just enough to allow air to escape. THEN, run the engine until fuel oil comes out of this vent in a solid stream. NEXT, tighten the air vent plug securely. Check the filter connections and oil lines for leaks and tighten if necessary.

FUEL OIL SPECIFICATIONS

The selection of fuel is an important factor in Diesel operation. Selection based on knowledge of the characteristics that govern quality and suitability of fuel oil will lead to more economical and satisfactory performances. Use oil of the following specifications.

PROPERTY	REQUIREMENTS	*A.S.T.M. METHOD
Cetane Number	45 Minimum	D 613
Pour Point	Max. 10°F. Below lowest expected temp.	D 97
Volatility --		
Initial Condensed	320°F. Minimum (Note 1)	
90% Condensed	500°F. Maximum (Note 3)	
End Point or final Boiling Point	550°F. Maximum (Note 3)	
S. U. Viscosity, 100°F.	30" - 40"	D 158 (Note 2)
Water and Sediment	0.05% Maximum	D 445 and D 446
Ash	0.01% Maximum	D 96
Flash Point	120°F. Minimum	D 482
Total Sulphur	0.5% Maximum	D 93
Corrosive Sulphur	Pass Test	D 129
Carbon Residue	0.2% Max. on 10% Residuum	D 130 (Note 4)
Alkali or Mineral Acids	Neutral	D 189
Odor	Non-offensive	D 663 or D 664

Note 1 - Operation under severe conditions in hot weather may necessitate specifying initial condensed point of 335°F. minimum, in order to prevent occurrence of vapor lock and irregular idling.

Note 2 - If kerosene or similar fuel is used, method D 86 applies.

Note 3 - Where fuel as recommended is not available, fuel not exceeding the following limits is suggested: 90% condensed at maximum 600°F. and maximum end point of 650°F.

Note 4 - Test should be conducted at 212°F. instead of 122°F.*

*American Society for Testing Materials

TP 3277

FUEL OIL STORAGE AND HANDLING

It is important that extreme care be exercised in the handling and storage of Diesel fuel oil. Absolute cleanliness and the absence of water in the fuel oil is essential to satisfactory operation. It is therefore recommended that wherever fuel oil is stored, adequate filtering equipment be provided. It is suggested that the fuel oil be doublefiltered from storage tank to pump and that filters are properly serviced according to instructions from the filter manufacturer.

In addition to servicing the filters, proper service of the dispensing system requires that approximately every ten days a hand pump be inserted in lowest portion of storage tank to remove the accumulated water and sludge. Some layouts will have a sludge collection pan for removal of dirt and water and hand pump will not be needed.

If fuel oil is obtained and stored in drums without the benefit of the above filtering arrangement, it is necessary that extreme caution be used in handling to assure absolute cleanliness. Drum should be provided with a pump which can be screwed or otherwise properly attached to the fuel outlet hole. Pump should be equipped with a good filter, the element of which can be removed and cleaned or replaced.

It is also advisable to provide a suitable dust cover for end of pump hose when not in used.

FUEL SYSTEM

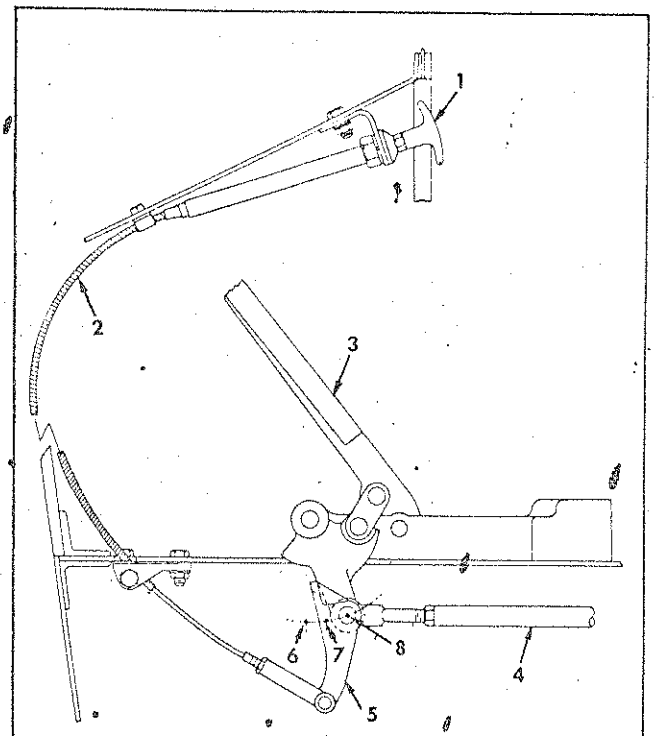


Figure 2—Throttle Hand Control

ACCELERATOR AND HAND THROTTLE

Accelerator pedal is connected to governor by means of rods, linkage and return springs. Adjustable yokes are provided at front and rear end of control rod and at cross shaft at front end of engine, to adjust length of rods.

Whenever engine is stopped, accelerator pedal must be pressed to release injector racks from "No Fuel" position before engine will start.

A ratchet type hand throttle is connected to accelerator linkage, as shown in figure 2, for convenience of operator. Refer to Operation (Sec. O, of this manual) for instructions on how to operate hand throttle.

FUEL TANK AND LINES

Front and rear fuel tanks are mounted before and after rear axle as illustrated in figure 3. Tanks are filled separately through filler necks extending to right hand side of body.

Fuel feed and return lines are special metal tubing and flexible hose. Metal lines are protected where necessary with loom and are securely clipped in place.

A selector valve, connected into the fuel lines as shown in figure 3, permits the fuel supply to be taken from either or both tanks. Selector valve is mounted at forward right hand side of engine compartment and is accessible through transmission inspection door.

INSPECTION

Tank mountings and line connections should be checked regularly and tightened if necessary.

Fuel lines should be checked periodically for distortion or fractures and repaired before leaks occur.

AIR INTAKE AND CLEANERS

Air for engine is taken in through louvered openings at right and left rear corners of body. Air passes through compartment at rear of rear seat into silencer then through air cleaners to engine blower as shown in figure 4.

AIR CLEANER

Three heavy duty oil bath air cleaners are mounted to manifold located at bottom of silencer through engine compartment doors. Cross section of air cleaner is shown in figure 5.

OPERATION

Following description of air cleaner operation shows clearly the necessity of periodic cleaning.

1. Assuming that air cleaner elements have just been cleaned and dipped in oil, and sumps filled with oil to preper level, operation is as follows: When engine starts, air is drawn into cleaners as illustrated in figure 4. Until speed of engine reaches about 100 rpm velocity of air is not sufficient to agitate pool of oil in sumps, but sudden reversal and impact of air stream will divert larger particles of dirt into sumps, and finer particles will be filtered out by oil wetted mesh.

2. As engine speed increases, velocity of air agitates pool of oil, and saturating spray is directed on mesh. Impact and reversal of air stream still throws off larger particles and oil sprayed mesh filters out remaining dirt.

3. As dirt is filtered out of air and settles into sump, oil in sump becomes thicker until it assumes consistency of wet cement if cleaner is not serviced soon enough. This thick substance is sprayed into lower part of mesh until solid mass is formed clogging lower portion so that air flow becomes restricted. Upper part of mesh soon dries out and particles of dirt are drawn through blower.

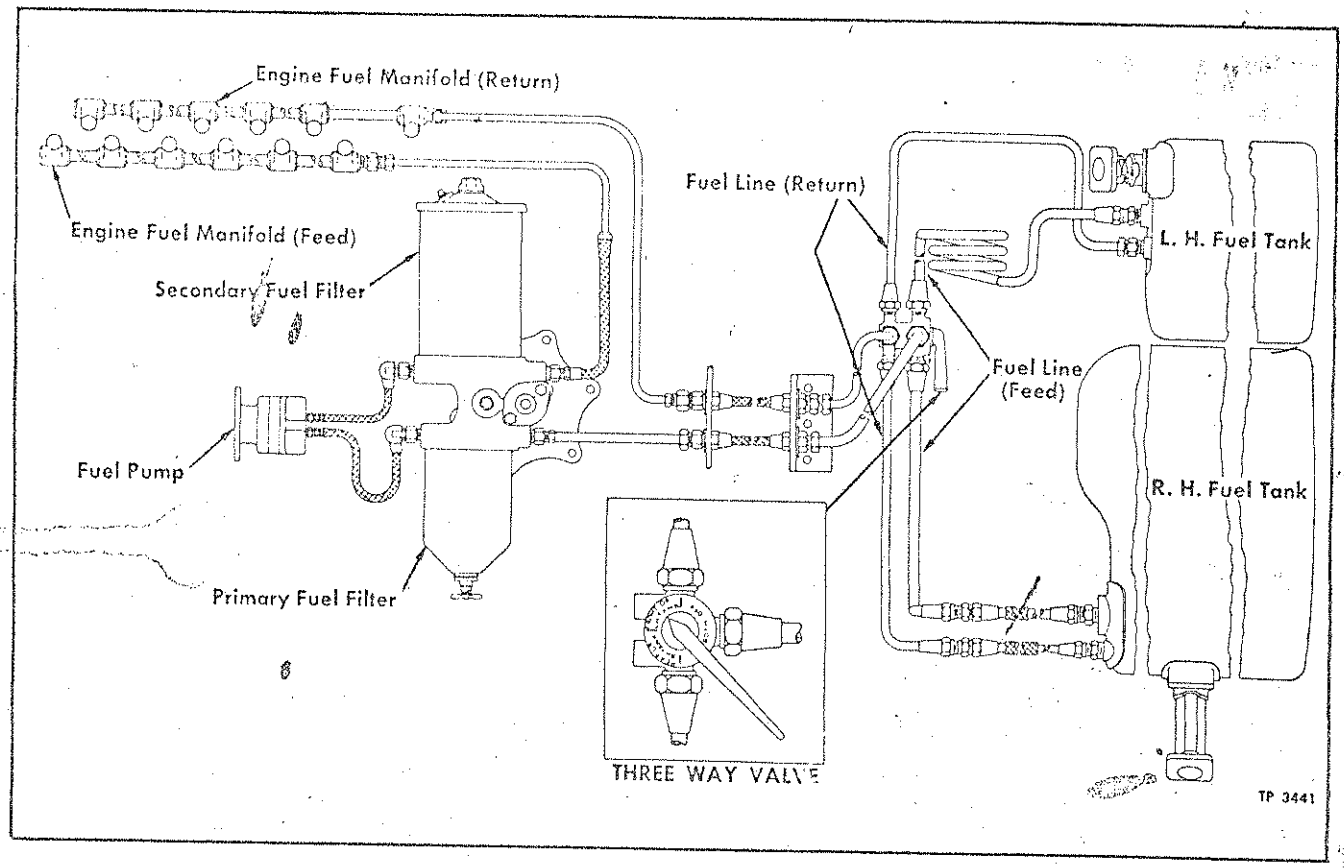


Figure 3—Fuel Tank and Lines

When consideration is given to the volume of air taken in by cleaner and amount of dirt present in average "road" air, importance of air cleaner maintenance may well be realized.

Conservative estimate of the amount of dirt taken into an air cleaner during a thousand mile operation may be 1/2 to 1-1/2 pounds. This quantity may vary more or less in different localities. In many localities, sand and fine abrasives are present in air.

When air cleaner is loaded and dirty, and is used past its saturation point, some of this fine abrasive will get past cleaner and considerably damage pistons, cylinder walls and bearings.

SERVICING AIR CLEANERS

Importance of keeping air cleaners in proper condition should be impressed on those responsible for mechanical upkeep of engine.

Air cleaners are used to keep road dust out of engine. This dust is loaded with minute particles of abrasive which, if permitted to enter engine, will cause rapid wear of cylinder walls, pistons and rings; with resultant loss of power and increase of oil and fuel consumption.

Unless air cleaners are cleaned periodically as service conditions require, they will not function properly, and in some instances, actually aggravate the condition which they are designed to prevent. If air cleaner is allowed to become clogged with dirt, and left in that condition, flow of air to blower will be restricted, thus causing increased fuel consumption, engine heating up, crankcase dilution, and otherwise affecting performance of engine.

For those reasons, air cleaner must be cleaned at regular intervals, at least every 1,000 miles, or more often if conditions warrant. Under adverse conditions or extensive operation on dusty or sandy roads, units should be cleaned every day or at least every 200 miles.

Air cleaners on vehicles operating in dust storm areas should be cleaned immediately after such storms occur.

CLEANING AIR CLEANER

Oil bath air cleaner must be cleaned in the following manner:

1. Loosen the two retaining clamps (one on each side) that retain the oil sump assembly to air cleaner outer shell. Remove sump.
2. Remove filter element from inner shell.
3. Clean filter element by plunging in clean

FUEL SYSTEM

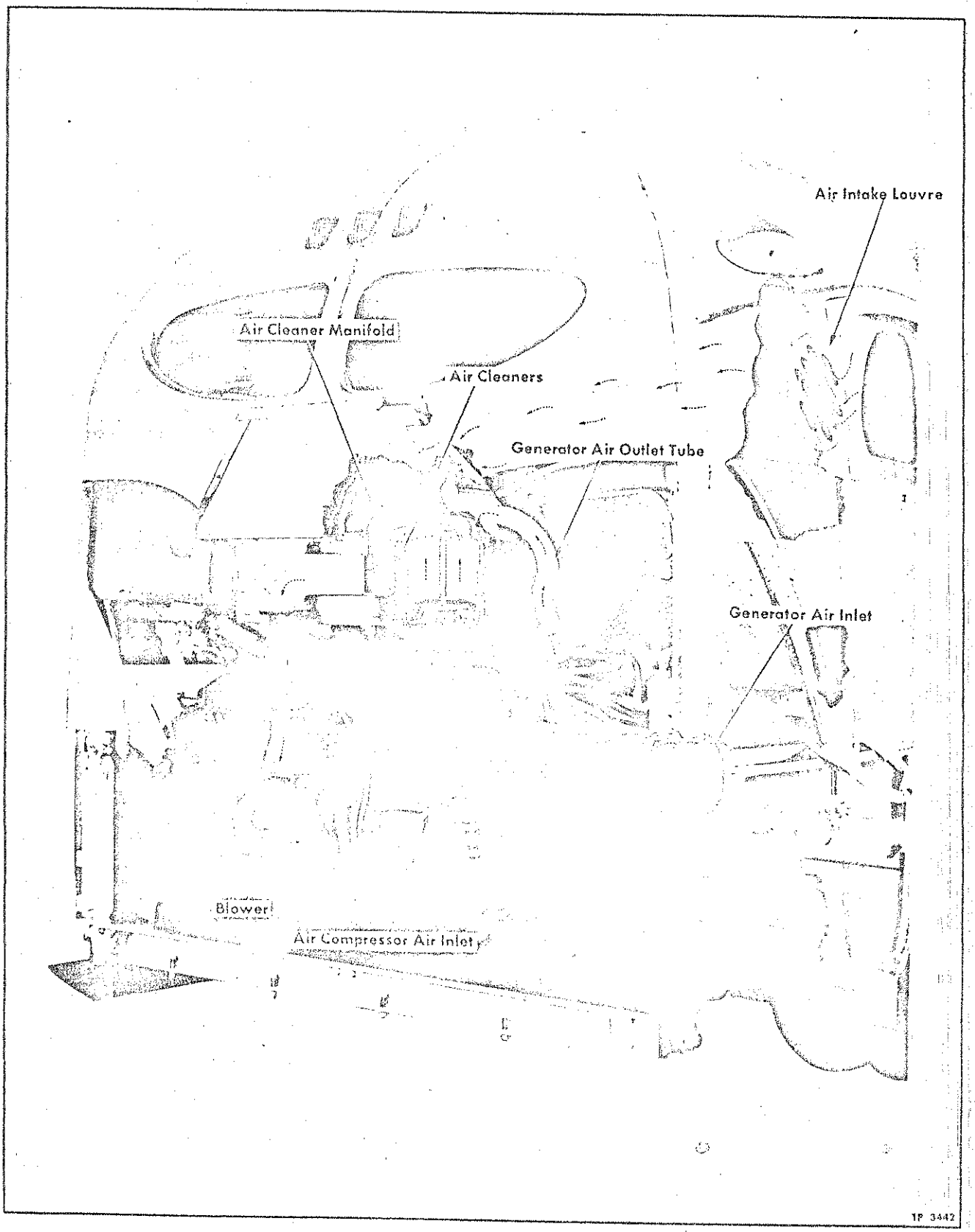


Figure 4—Air Intake System

gasoline or other suitable cleaning fluid until entirely clean.

4. Allow element to dry. DO NOT BLOW DRY WITH COMPRESSED AIR.

5. Clean out oil sump thoroughly then fill it to proper level with clean engine oil as shown in Lubrication (Sec. 13 of this manual). In the event oil becomes congealed due to cold weather, flush and refill with a lighter oil.

6. Air passage between inner and outer cleaner shell may be cleaned by removing attaching screws at cleaner manifold.

7. Assemble parts to cleaner by placing filter element in position in inner cleaner shell, then sump with oil at proper level into position on outer cleaner shell.

Engage clamp securing sump to outer shell to complete assembly. NOTE: Seal between sump and outer cleaner shell must be in good condition to seal air tight.

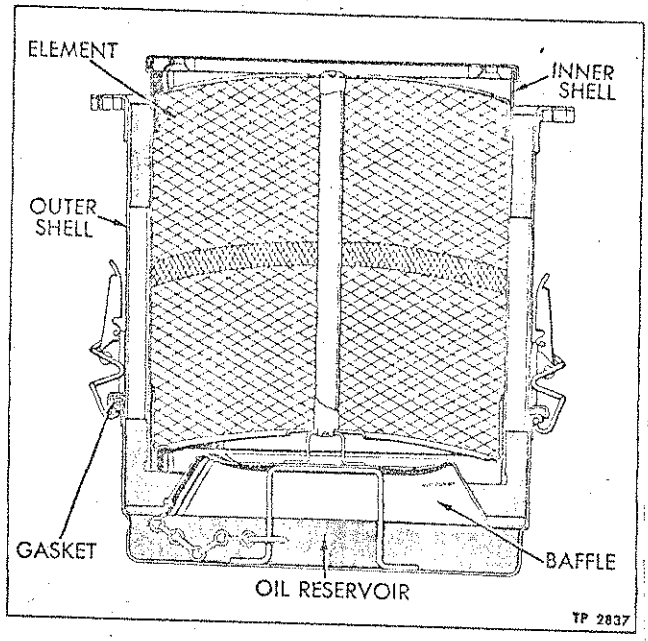


Figure 5—Sectional View of Air Cleaner

FUEL INJECTORS

For information on fuel injectors refer to Diesel Engine Maintenance Manual (Form X-4517).

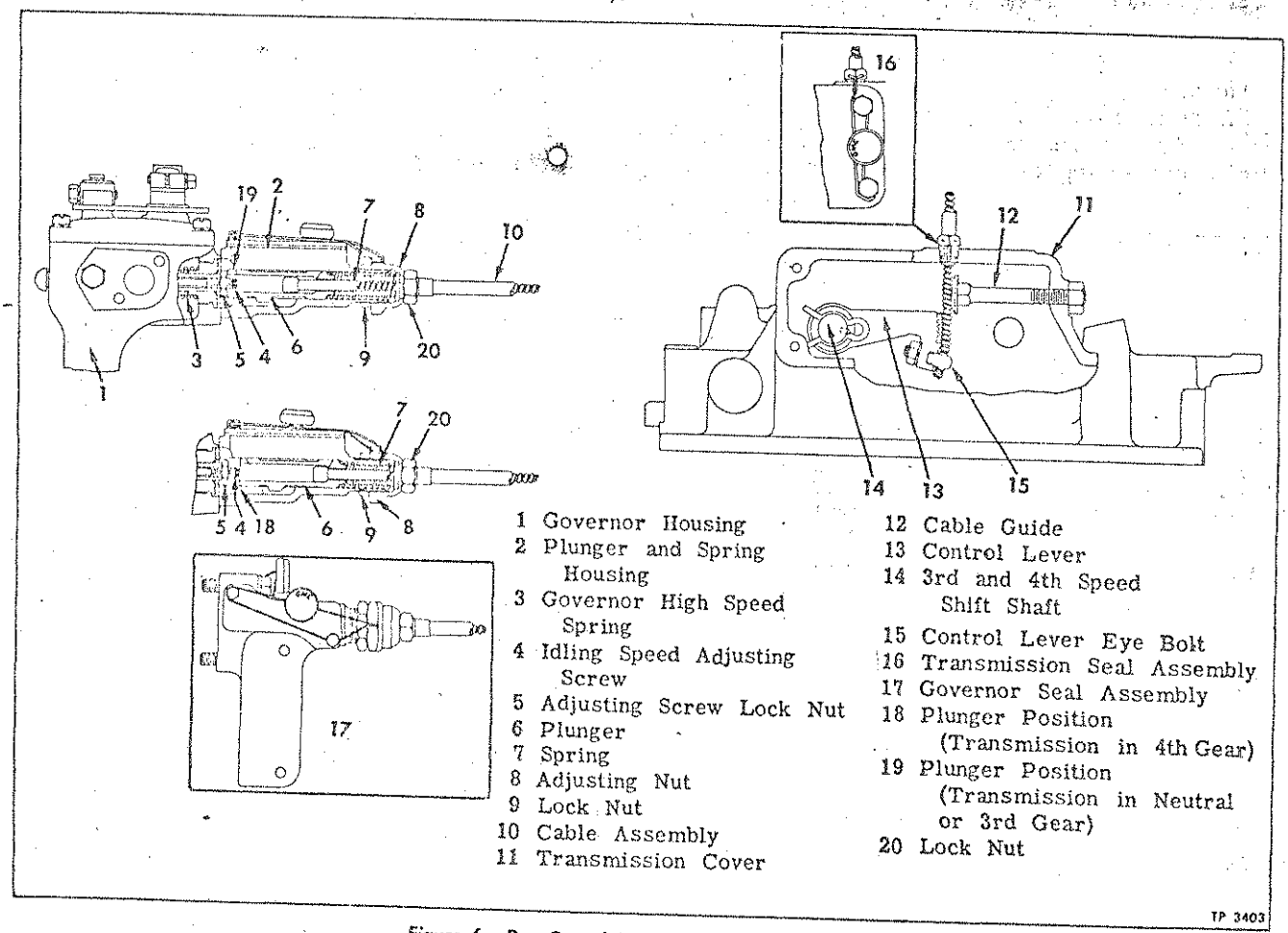


Figure 6—Duo-Speed Governor Control Adjustment

FUEL SYSTEM

FUEL PUMP

For information on fuel pump refer to Diesel Engine Maintenance Manual (Form X-4517).

GOVERNOR

For information on governor proper, refer to Diesel Engine Maintenance Manual (Form X-4517). However, vehicles covered by this manual are equipped with a Duo-Speed governor control which works in conjunction with governor proper. For description and adjustment of Duo-Speed governor control see following paragraph. Refer to "Specifications" at end of this section for maximum allowable engine rpm.

DUO-SPEED GOVERNOR CONTROL

Duo-speed governor control provides two stages of engine governed speed depending upon transmission gear selected. With this arrangement, increased engine speed is provided when vehicle is being operated in lower transmission gears where full power may be required. Refer to "Specifications" at end of this section for engine governed speeds.

Duo-speed governor control consists essentially of a flexible control cable connecting transmission shifting mechanism with Duo-speed governor plunger and spring as shown in figure 6.

When vehicle is operated in 1st, 2nd, or 3rd gear, Duo-speed governor spring (fig. 6) supplements high speed spring in governor proper, thereby permitting increased engine speed. As transmission is shifted into 4th gear, control cable moves plunger outward overruling action of the spring which allows governor to operate in regular manner.

ADJUSTMENT

Two adjustments are provided on Duo-speed governor control and may be accomplished as follows:

CONTROL CABLE ADJUSTMENT

In the event cable has been disconnected from transmission lever it may be readjusted in following manner:

1. With transmission in neutral, push control cable into conduit until cable end seats in plunger (do not compress spring), then pull cable out 3/8 inch and secure to transmission lever with eye bolt.
2. Install covers at transmission and Duo-speed adapter, then seal as shown in figure 6.

PLUNGER AND SPRING ADJUSTMENT (Fig. 6)

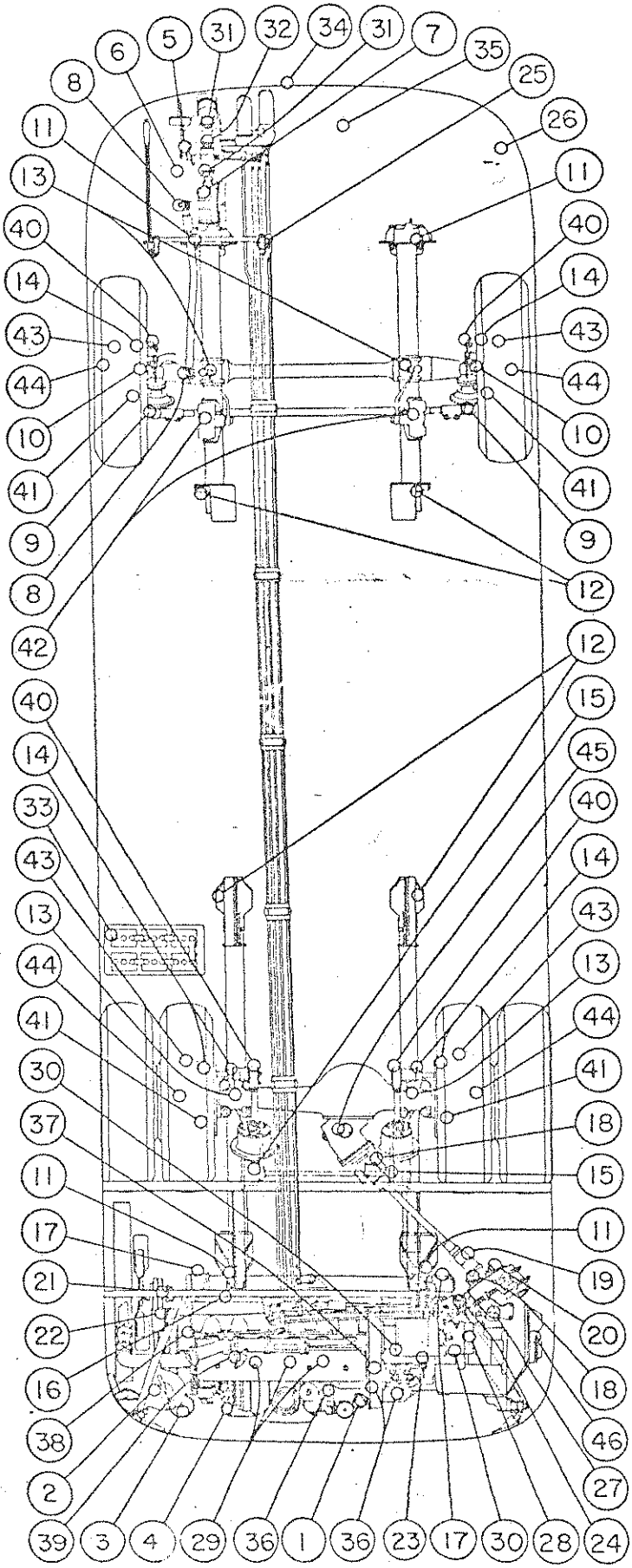
1. With transmission in neutral, screw adjusting nut "8" in or out as necessary to obtain engine speed of 2100 rpm - no load.
2. With transmission in 4th gear, accelerate engine to full throttle and check to make certain there is clearance between Duo-speed governor plunger and engine governor idling adjusting screw lock nut "5".
3. Tighten lock nuts "9" and "20" then install adapter cover and seal as shown.

SPECIFICATIONS

FUEL FILTER	
Primary (Lower)	
Make	AC
Type	T2
Secondary (Upper)	
Make	AC
Type	T2
AIR CLEANERS	
Make	AC
Type	Oil Bath
FUEL TANK	
Capacity (Gals.)	
Front	Approx. 83.5
Rear	39.5
GOVERNOR	
Maximum Allowable Engine RPM (No Load)	
1st, 2nd, and 3rd Gear	2100
4th Gear	1840

FACTORY ENGINEERED LUBRICATION SERVICE

THIS PAGE SHOWS WHERE AND TELLS HOW OFTEN EACH ITEM SHOULD BE LUBRICATED



Item No.	Description	Lub. Period (Miles)	Item No.	Description	Lub. Period (Miles)	Item No.	Description	Lub. Period (Miles)
1	Engine	Daily	17	Motor Mount Brackets	1,500	33	Battery Terminals	1,500
2	Engine Auxiliary Oil Tank	Daily	18	Prop. Shaft "U" Joints	1,500	34	Destination Sign Cranks	1,500
3	Oil Filter		19	Prop. Shaft Slip Joint	1,500	35	Roller & Wedge Rods (Spare Tire Compt.)	1,500
4	Oil Strainer		20	Hand Brake Anchor Pin	1,500	36	Starter	3,000
5	Clutch Pedal Cross Shaft	1,500	21	Fan Pulley Bearing	1,500	37	Clutch Pilot Bearing	3,000
6	Steering Bevel Gear Housing	1,500	22	Fan Idler Pulley	1,500	38	Shutter Air Filter	3,000
7	Steering Gear Housing	1,500	23	Clutch Release Shaft Ends	1,500	39	Shutter Thermostat	3,000
8	Steering Drag Link Ends	1,500	24	Hand Brake Bell Crank Idler	1,500	40	Slack Adjusters - F. & R.	15,000
9	Steering Tie Rods Ends	1,500	25	Control Rod Linkage	1,500	41	Brake Shoe Anchor Pins - F. & R.	15,000
10	Steering Knuckles	1,500	26	Door Hinges	1,500	42	Shock Absorber (Front)	15,000
11	Spring Pins - F. & R.	1,500	27	Clutch Release Bearing	1,500	43	Brake Cam & Shoe Rollers F. & R.	15,000
12	Spring Shackles - F. & R.	1,500	28	Generator Air Cleaner	1,500	44	Wheel Bearings - F. & R.	15,000
13	Spring Center Bolts - F. & R.	1,500	29	Blower Air Cleaner	1,500	45	Rear Axle Differential (fill)	15,000
14	Brake Camshafts - F. & R.	1,500	30	Generator	1,500	46	Transmission	15,000
15	Sway Bar Bushings	1,500	31	Steering Shaft "U" Joints	1,500			
16	Control Rod Bell Cranks	1,500	32	Steering Shaft Slip Joint	1,500			

NOTE: Reference should be made to back of this chart and to the notes in the Lubrication section of this manual.

GM COACH

GM COACH

MODEL PD-3751 LUBRICATION CHART

THE RIGHT LUBRICANT • AT THE RIGHT PLACE • AT THE RIGHT TIME

THIS PAGE TELLS WHAT LUBRICANT TO USE AND HOW MUCH OF IT TO APPLY

Special information regarding Lubricant will be found in Lubrication section under "Lubrication Notes" as indicated in following right hand column.

ITEMS TO BE LUBRICATED		WHAT LUBRICANT TO USE			See
Same as listed on Lubrication Chart		Refer to Lub. Specifications		CAPACITY	Note
No.	Name	Sym.	Remarks	OR METHOD	No.
1	Engine	E	Keep to "Full" Mark	15 Qts.	1
2	Engine Auxiliary Oil Tank	E	Fill	12 Qts.	1
3	Oil Filter	E	Replace Element at Engine Drain		1
4	Oil Strainer	E	Clean at Engine Drain		1
5	Clutch Pedal Cross Shaft	C	One Fitting	Pressure Gun	4
6	Steering Bevel Gear Housing	ES	One Fitting	Pressure Gun	2
7	Steering Gear Housing	ES	To Level of Filler Plug	Pump Gun	2
8	Steering Drag Link Ends	C	One Fitting Each End	Pressure Gun	4
9	Steering Tie Rods Ends	C	One Fitting Each End	Pressure Gun	4
10	Steering Knuckles	C	Two Fittings Each Side	Pressure Gun	4
11	Spring Pins - F. & R.	C	Two Fittings Each Side	Pressure Gun	4
12	Spring Shackles - F. & R.	C	Four Fittings Each Side	Pressure Gun	4
13	Spring Center Bolts - F. & R.	C	One Fitting Each Spring	Pressure Gun	4
14	Brake Camshafts - F. & R.	C	1 Front - 2 Rear	Pressure Gun	4
15	Sway Bar Bushings and Links	S12	Apply	Brush or Spray	10
16	Control Rod Bell Cranks	C	Three Fittings at Bulkhead	Pressure Gun	4
17	Motor Mount Brackets	C	Two Fittings	Pressure Gun	4
18	Prop. Shaft "U" Joints	G	One Fitting Each Joint	Pressure Gun	3
19	Prop. Shaft Slip Joint	C	One Fitting	Pressure Gun	4
20	Hand Brake Anchor Pin	C	One Fitting	Pressure Gun	4
21	Fan Pulley Bearing	S2	One Fitting	Pressure Gun	5
22	Fan Idler Pulley	S2	One Fitting	Pressure Gun	5
23	Clutch Release Shaft Ends	C	One Fitting Each End	Pressure Gun, Sparingly	4
24	Hand Brake Bell Crank Idler	C	One Fitting	Pressure Gun	4
25	Control Rod Linkage	E	Brush or Spray	Apply	1
26	Door Hinges	E	Apply	Oilcan	1
27	Clutch Release Bearing	S2	Grease Cup	One Turn Down	5
28	Generator Air Cleaner	E	Wash & Dip in Light Oil	Allow to Drain	1
29	Blower Air Cleaners	E	Keep to Full Mark	2 Qts. Each	1
30	Generator	S2	Two Grease Cups	Keep Filled	5
31	Steering Shaft "U" Joints	G	One Fitting Each Joint	Pressure Gun	3
32	Steering Shaft Slip Joint	C	Fill	Pump Gun	4
33	Battery Terminals	S3	Keep Coated	Apply	6
34	Destination Sign Cranks	C	Sparingly	Apply	4
35	Roller & Wedge Rods (Spare Tire Compt.)	E	Apply	Oilcan	1
36	Starter	E	Three Oil Cups	Oilcan	1
37	Clutch Pilot Bearing	S2	Through Temporary Fitting in Flywheel	Sparingly Hand Gun	5
38	Shutter Air Filter	S13	Remove Plug-Inject Fluid	1 Oz.	11
39	Shutter Thermostat	S10	Disconnect Inlet Line Inject Fluid	1 Oz.	9
40	Slack Adjusters	C	Through Temporary Fittings	Pressure Gun	4
41	Brake Shoe Anchor Pins - F. & R.	S2	Through Temporary Fittings	Sparingly Hand Gun	5
42	Shock Absorber (Front)	S6	Keep Filled	Fluid Gun	8
43	Brake Cam & Shoe Rollers - F. & R.	S5	Apply	Sparingly	7
44	Wheel Bearings F. & R.	S2	Hand Pack or Use Lubricator Do Not Use Pressure Gun		5
45	Rear Axle Differential (fill)	G	Fill to Level of Filler Plug		3
46	Transmission	ES	To Level Mark on Dip Stick		2

The Following Items Require Lubrication At Time of Assembly

	Water Pump Bearings		Sealed Type	Pre-Lubricated
	Control Rod Support Bearings	E		At Assembly 1
	Shutter Linkage	E	At Joints Only	Sparingly 1
	Steering Column Upper Bearing	S2	Hand Pack	As Required 5
	Clutch Shaft Splines	S5	Apply Evenly	Sparingly 7

LUBRICANT RECOMMENDATIONS

E — ENGINE OIL

Engine oils of highest quality should be used. The oils available vary in lubricating qualities and stability. A highly refined petroleum oil containing adequate amounts of suitable additives such as oxidation inhibitors and detergent-dispersant additives is essential for satisfactory performance in heavy duty service. Refer to Note No. 1.

ES — ENGINE OIL-SPECIAL

Oil selected must be a good quality highly refined S.A.E. 50 oil, such as aviation grade engine oil. NOTE: Where aviation type engine oil is not available, S.A.E. 50 Heavy Duty engine oil having oxidation resistance, detergent-dispersant and anti-foam characteristics may be used as optional lubricant. Refer to Note No. 2.

G — GEAR OIL

Straight mineral gear oil of best quality and stability free from foreign substances, and having ability to form a protecting film of oil between the meshing teeth should be used at all times. Refer to Note No. 3.

C — CHASSIS LUBRICANT

Chassis Lubricant should be a high grade calcium or aluminum soap pressure gun grease. Sodium soap grease may be used as chassis lubricant, but more frequent application may be required during wet weather. Refer to Note No. 4.

S-2 — 15% SODIUM SOAP GREASE

A short fibre non-fluid grease containing approximately 15% sodium soap, and having a high melting point. Refer to Note No. 5.

S-3 — PETROLEUM JELLY

Petroleum jelly or petrolatum. Refer to Note No. 6.

S-5 — GRAPHITE GREASE

A high temperature grease containing graphite, or other inert materials. Refer to Note 7.

S-6 — SHOCK ABSORBER FLUID

A special shock absorber fluid should be used whenever additional fluid is necessary. Refer to Note No. 8.

S-10 — DENATURED ALCOHOL

A good grade of commercial denatured alcohol. Refer to Note No. 9.

S-12 — HYDRAULIC BRAKE FLUID

Hydraulic brake fluid should be Delco-Super #9 or #10 or Wagner Lockheed #21-11. Refer to Note No. 10.

S-13 — AIR FILTER FLUID

Special Kysor air filter fluid should be used. Refer to Note No. 11.

Lubrication

Contents of This Section

Related Subjects in Other Sections

Refer to All Sections in Manual for Design and Maintenance Information.

It is essential that care be exercised in the purchase and application of lubricants.

The application of the right lubricant in the right place and at the right time will greatly reduce the actual cost of transportation delivered.

THE RIGHT LUBRICANT

In your selection of the proper brand of oil it is desirable to consider the reputation of the refiner or marketer. He is responsible for the quality of this product and his reputation is the vehicle owner's best indication of quality.

THE RIGHT PLACE

Lubrication fittings or accessible lubrication points have been incorporated on all mechanical units of the vehicle, where lubrication is needed.

THE RIGHT TIME

Intervals at which various points on the chassis should receive attention are indicated on lubrication chart. Intervals are based upon actual experience and tests, as well as careful consideration of design and purpose of parts to be lubricated.

HOW TO USE THIS LUBRICATION SECTION

Select the lubrication chart applying to the vehicle to be serviced. This chart will locate the lubrication points, indicate the type (or symbol) of lubricant, give the recommended mileage intervals, and refer to the correct instruction note for each item. Instruction notes should be read and followed carefully when applying lubricant.

LUBRICATION

LUBRICATION NOTES

These notes, which correspond to numbers placed opposite the (right hand column) lubrication items on lubrication charts, include explanation of lubrication symbols, special lubrication instructions and references to detailed instructions in other sections of this manual. Use these notes in conjunction with the lubrication chart.

NOTE NO. 1 ENGINE OIL

(See Symbol E on Chart)

TYPES OF OIL

Crankcase oils in service, unless protected against oxidation, may form sludge and varnish and under some conditions corrosive acids.

To minimize the formation of these harmful decomposition products and to supply the type of oil best suited for the different operating conditions, the oil industry markets several types of crankcase oils. These types are defined by the General Committee, Division of Marketing of the American Petroleum Institute as follows:

"REGULAR MOTOR OIL, this term shall be used to designate a straight mineral oil. Oils of this type are generally suitable for use in internal combustion engines under moderate operating conditions."

"PREMIUM MOTOR OIL, this term shall be used to designate an oil having proved oxidation stability and bearing corrosion preventive properties. Oils of this type are generally suitable for use in internal combustion engines where operating conditions are such that regular oils do not give satisfactory service."

"HEAVY DUTY MOTOR OIL, this term shall designate an oil having oxidation stability, bearing corrosion preventive properties, and detergent-dispersant characteristics. Oils of this type are generally suitable for use in both High Speed Diesel and Gasoline Engines under heavy duty service conditions."

RECOMMENDED TYPE OF OIL

In heavy duty commercial service the crankcase oil usually operates at a much higher temperature than in light duty service and consequently is more subject to deterioration. Varnish on the pistons, valve stems and tappets causes sluggish operation of the engine. Sludge will eventually clog the oil pump screen, oil passages and oil control rings.

The Regular or straight mineral motor oils, are generally used under normal driving conditions in some light commercial vehicles under very light service conditions and passenger car engines. However, this type of oil is not recommended for Diesel engines used in vehicles covered by this manual.

The Premium motor oils can be used in gasoline engines in commercial service where operating conditions are normal or average.

The Heavy Duty motor oils are recommended for use in all heavy duty commercial service gasoline engines and must be used in Diesel engines covered by this manual. The heavy duty motor oils contain detergent-dispersant compounds which tend to hold in suspension the foreign contaminants which are then drained with the oil at oil change periods.

S.A.E. VISCOSITY NUMBERS

The S.A.E. viscosity numbers constitute a classification of lubricants in terms of viscosity or fluidity, but with no reference to any other characteristics or properties.

The S.A.E. viscosity numbers have been adopted by practically all oil companies, and no difficulty should be experienced in obtaining the proper viscosity grade in the different types of engine oils to meet seasonal requirements.

Successful operation of Diesel engine requires the careful selection of a Heavy Duty detergent-dispersant type lubricating oil. The oil must be the Heavy Duty type which has proved oxidation stability, bearing corrosion preventive properties and detergent-dispersant characteristics. Heavy Duty oils pick up and suspend fine particles of undesirable matter, thereby preventing their formation on engine internal surfaces. These contaminants are then drained off at time of oil change.

Use S.A.E. 30 engine oil for all normal operating conditions except; when temperatures consistently below +20°F. are encountered. Where prolonged engine exposure to temperatures below freezing is unavoidable use of 20W between +20°F. and 0°F. or 10W below 0°F. is suggested to facilitate cold starting.

Check oil level daily; keep to "full" mark

on dip stick. When oil filter element is renewed, oil strainer cleaned, or oil changed, engine should be run after filling and oil level rechecked.

DRAINING

The frequency with which crankcase oil must be changed depends upon the type and quality of oil used, the type or severity of operation, and the condition of the engine. It is therefore impossible to make a general recommendation concerning mileage intervals between oil changes. The oil should be changed often enough to keep it nonabrasive and noncorrosive. Oil changing is closely related to filter element and air cleaner element cleaning and changing, the frequency of which also depends upon the condition of operation mentioned above.

Laboratory tests of oil drained from the engine, conducted by the oil supplier of by another suitable laboratory should be helpful in determining the greatest advisable interval between oil and filter element changes for your operation. Whether such tests are conducted or not, your oil supplier should be able to recommend suitable oil change periods for his oil in your operation.

RESERVE OIL TANK

Reserve oil tank serves as a reservoir of engine oil for replenishing oil supply in engine crankcase. Refer to Operation (Sec. O of this manual) for complete instructions.

CHANGING TYPE OF OIL

In some instances operators may be using "Regular" or "Premium" engine oils instead of the recommended "Heavy Duty" oil. If this is the case the following procedure is recommended when "Heavy Duty" type engine oil is first used. The engine should not be run for more than 24 hours on the new oil, then drained and crankcase refilled. This prevents any dangerous obstruction of oil pump intake screen or oil strainer by any previously formed oxidation deposits which might be loosened by purging action of oil. The second crankcase filling should be drained out after running 40 hours, at which time oil filter element should be renewed. Following these two oil changes the previously recommended or newly established oil drain periods can be followed.

OIL STRAINER

Whenever engine oil is drained the oil strainer element and strainer should be cleaned. Wash inner and outer surfaces of element and strainer in suitable cleaning solvent. A fine bristle (not wire) brush is satisfactory for cleaning.

OIL FILTER

Whenever engine oil is drained the oil filter element should be changed and filter cleaned. Filter element changing and cleaning filter should remove all accumulations of sludge and harmful abrasives that might otherwise contaminate the clean oil.

AIR CLEANERS (BLOWER)

Keep oil level in air cleaners to "full" mark. At intervals recommended on lubrication chart, or more often if conditions warrant, clean and refill. Use the same grade and type of oil as used in crankcase.

GENERATOR AIR CLEANER (Oil Wetted Type)

At intervals recommended on lubrication chart, or more often if conditions warrant, remove and clean in cleaning solvent. Dry thoroughly. Use light grade oil to wet mesh element, then allow excess oil to drain off before installing.

STARTING MOTOR

At intervals recommended on lubrication chart apply S.A.E. 20 engine oil at three oilers.

DOOR HINGES

At intervals recommended on lubrication chart, door hinges and operating mechanism should be lubricated with light engine oil. Operate door after lubricating to permit oil reaching friction points.

SHUTTER LINKAGE

As recommended on lubrication chart, radiator shutter linkage should be lubricated only when linkage is new.

LINKAGE

At all linkage joints and clevis pins apply oil with brush, spray or hand oil can.

ROLLERS AND WEDGE RODS (Spare Tire Compartment)

At intervals recommended on lubrication chart apply engine oil to rollers and wedge rods. Refer to Body (Sec. 3B of this manual) for location and accessibility.

LUBRICATION

NOTE NO. 2 ENGINE OIL – SPECIAL

(See Symbol ES on Chart)

The type of oil, indicated by symbol "ES," must be carefully selected, as ordinary engine and gear oils are not satisfactory. Oil must be of good quality S.A.E. 50 such as aviation grade engine oil. NOTE: Where aviation type of engine oil is not available, S.A.E. 50 Heavy Duty engine oil having detergent-dispersant properties, oxidation resistance, and anti-foam characteristics may be used as optional lubricant.

TRANSMISSION

Keep lubricant to "full" mark on dip stick. Drain and refill at least every 15,000 miles. Drain only while transmission is warm. NOTE: Do not use extreme pressure or hypoid lubricants in transmission.

STEERING BEVEL GEAR HOUSING

Use pressure gun on fitting and apply until grease appears at overflow tube.

STEERING GEAR HOUSING

Remove filler plug. Use pump gun and apply until lubricant is up to level of filler plug. Install filler plug.

NOTE NO. 3 GEAR OIL

(See Symbol G on Chart)

Use gear oil of best quality. Oils undergo chemical changes at high temperature with thickening as the result. This instability, which should not be confused with viscosity (body), may produce oil that is too thick for adequate lubrication. Gear oils most resistant to thickening are filtered steam refined cylinder stock or bright stocks.

REAR AXLE

Keep lubricant to level of filler plug. Drain and refill at least every 15,000 miles. Drain while axle is warm, preferably immediately after operation. Use S.A.E. 90 gear oil for winter and S.A.E. 140 for summer.

PROPELLER SHAFT UNIVERSAL JOINT

Use pressure gun at fitting and apply until lubricant is visible at relief valve. Use S.A.E. 140 gear oil for summer, and S.A.E. 90 during winter.

STEERING SHAFT UNIVERSAL JOINTS

Universal joints are not provided with relief valves. Lubricant until lubricant appears around journals.

NOTE NO. 4 CHASSIS LUBRICANT

(See Symbol C on Chart)

Chassis lubricant should be used at all points indicated by symbol "C" on lubrication chart.

All pressure gun lubrication points must be clean before applying gun. Replace all broken or missing fittings. Apply sufficient lubricant to thoroughly lubricate entire bushing or bearing.

Chassis lubricant should be a high grade calcium or aluminum soap pressure gun lubricant. Sodium soap grease may be used as chassis lubricant, but more frequent application may be required during wet weather.

NOTE NO. 5 15% SODIUM SOAP GREASE

(See Symbol S2 on Chart)

A short fibre non-fluid sodium soap (approximately 15%) grease having a high melting point.

GENERATOR

Turn cups down at intervals specified. Refill cups when empty.

CLUTCH RELEASE BEARING

Turn handle down one turn, or until cup begins to turn hard indicating that lubricant is under pressure. Refill cup when empty.

WHEEL BEARINGS

Remove wheel bearings as instructed in Hubs and Bearings (Sec. 19A of this manual). Wash bearings, hub and spindle in cleaning solvent. Inspect hub and bearings. Coat spindle and inside of hub with thin coat (approximately 1/8" thick) of grease to prevent rusting. Lubricate bearings thoroughly, using a lubricator or by hand pack method. Be sure lubricant reaches into all spaces of the bearing. DO NOT FILL HUB. Reinstall and adjust bearings as directed in "Hubs and Bearings" (Sec. 19A of this manual).

CLUTCH PILOT BEARING

Rotate flywheel until plug appears at opening in flywheel. Remove plug and install temporary fitting. Use hand pressure gun to apply lubricant sparingly. Remove fitting and replace plug.

BRAKE SHOE ANCHOR PINS

Remove plugs, install temporary fittings. Use pressure gun, apply lubricant sparingly. Remove temporary fittings and replace plugs.

FAN PULLEY BEARING

At intervals indicated on lubrication chart, apply specified lubricant through fitting until lubricant appears at overflow tube.

FAN IDLER PULLEY

At intervals indicated on lubrication chart, apply specified lubricant through fitting until lubricant appears at relief hole in end of shaft.

STEERING COLUMN UPPER BEARING

Bearing should be lubricated at time of assembly with recommended lubricant. Refer to "Steering Gear" (Sec 16 of this manual) for procedure.

NOTE NO. 6 PETROLEUM JELLY

(See Symbol S3 on Chart)

BATTERY TERMINALS

Keep battery cables clean. At regular periods, remove cables, clean terminals on cables and battery. Apply petroleum jelly after tightening terminals to prevent corrosion.

NOTE NO. 7 GRAPHITE GREASE

(See Symbol S5 on Chart)

A high temperature grease containing graphite or other inert materials.

CLUTCH SHAFT SPLINES

At time of assembly apply lubricant to clutch shaft splines and hub. Do not use an excessive amount of lubricant as it may reach the facings.

BRAKE CAM AND SHOE ROLLERS

At intervals specified on lubrication chart or whenever accessible apply lubricant to brake camshaft cams and shoe rollers. Application of lubricant to these points is important if brake efficiency is to be maintained.

LUBRICATION

NOTE NO. 8 SHOCK ABSORBER FLUID
(See Symbol S6 on Chart)

A special shock absorber fluid should be used whenever additional fluid is necessary.

SHOCK ABSORBERS

At specified intervals level of fluid in shock absorbers should be checked. Disconnect link at shock absorber arm as directed in "Springs" (Sec. 15 of this manual). Remove plug from shock absorber body. Move shock absorber arm up and down slowly as fluid is added. Continue arm movement and adding operations until fluid level remains at plug opening level. Replace plug and reconnect link.

NOTE NO. 9 DENATURED ALCOHOL
(See Symbol S10 on Chart)

Use alcohol anti-freeze solutions as directed in "Cooling System" (Sec. 6B of this manual).

SHUTTER THERMOSTAT

Disconnect line at thermostat and inject 1 ounce denatured alcohol at intervals indicated on lubrication chart. Refer to "Radiator, Shutter, Thermostat" (Sec. 6B of this manual) for complete instructions.

NOTE NO. 10 HYDRAULIC BRAKE FLUID
(See Symbol S12 on Chart)

Fluid recommended for this application should be Delco-Super #10 or Wagner Lockheed #21-11.

SWAY-BAR BUSHINGS AND SHOCK ABSORBER LINKS

At intervals recommended on lubrication chart, sway-bar rubber bushings and shock absorber links should be sprayed or brushed with recommended fluid which serves as a rubber preservant.

NOTE NO. 11 AIR FILTER FLUID
(See Symbol S13 on Chart)

Recommended fluid for this application is a special air filter fluid which is compounded especially for use in this unit.

SHUTTER AIR FILTER

Remove plug at top of filter reservoir. Inject 1 ounce of recommended fluid at specified intervals. Larger quantities or more frequent fillings are not recommended as system may be overloaded. Replace plug.

Weekly, during summer months, or daily during winter open the pet cock at bottom of filter to drain accumulated moisture. Drain under pressure.

Spring Suspension

Contents of This Section

Related Subjects in Other Sections

Vehicle chassis and body are supported by semi-elliptic type springs. Front springs are mounted on I-beam of front axles (fig. 1), while rear springs are suspended from rear axle housing (fig. 2). Each front spring assembly is attached to front axle with two U-bolts. Rear springs are bolted to rear axle housing with four straight bolts. Front ends of front springs are held in stationary brackets; rear ends are shackled to allow longitudinal movement (fig. 1). Rear springs are shackled at forward ends, while rear ends are held in stationary brackets (fig. 2).

Spring leaves are held together and in alignment by center bolts and by four rebound clips. Each clip consists of a "U" shaped strap with a bolt passing through upper ends of clip and over top spring leaf. Bottom of "U" is riveted to shortest leaf which clip retains.

To prevent excessive damage in the event of accidental spring breakage at spring eye, front springs are equipped with a safety bar at pivoted end. Rear springs are equipped with safety straps at pivoted end for the same purpose.

GENERAL SPRING MAINTENANCE

LUBRICATION

On front springs, lubrication fitting is installed in a drilled opening in front axle, which leads to center bolt, as shown in figure 1. On rear springs, lubrication fitting is installed in an adapter threaded onto center bolt (fig. 2). Center bolts are grooved to permit passage of lubricant to center portion of spring leaves.

WARNING: Excessive lubrication of spring leaves tends to make springs too flexible, which will decrease life of springs, and should be avoided. Refer to Lubrication (Sec. 13, of this manual) for lubrication directions.

Threaded type shackle pins are used on both front and rear springs. Pins are drilled and equipped with pressure gun lubrication fittings, (figs. 1 and 2), to provide facilities for lubricating spring eye bushings and frame bushings. NOTE: Upper shackle pin bushing, on left rear spring, is lubricated through tube mounted in shackle bracket. Shackle pins should be lubricated periodically as directed in Lubrication (Sec. 13, of this manual).

Do not lubricate shock absorber linkage or sway bar linkage as links are rubber bushed and lubricant has a deleterious effect on rubber.

TIGHTENING

At regular intervals, check rebound clip bolts and tighten sufficiently to hold spring leaves in alignment without restricting free movement of leaves. Loose rebound clip bolts may permit spring leaves to shift, shearing head of spring center bolt and causing misalignment of axles.

IT IS IMPERATIVE THAT CENTER BOLTS BE KEPT TIGHT. When center bolts are loose, spring leaves are not efficiently lubricated. In order to tighten front spring center bolt, it is necessary to detach front spring from front axle. Rear spring center bolt nut may be tightened after lubrication fitting and adapter have been removed.

Rear spring pins should be inspected periodically and drawn up until shackle plate rests snugly against shoulder of shackle pin; so that shackle plate will not oscillate on neck of shackle pin.

Spring U-bolts should be checked for tightness regularly; and, if loose, should be tightened with spring under normal load. This is done to remove camber from spring since sufficient force usually cannot be applied to U-bolt nuts to compress an unloaded spring.

Spring anchor bolts and front spring shackle clamp bolts should be kept tight to eliminate excessive shackle pin wear.

SPRING SUSPENSION

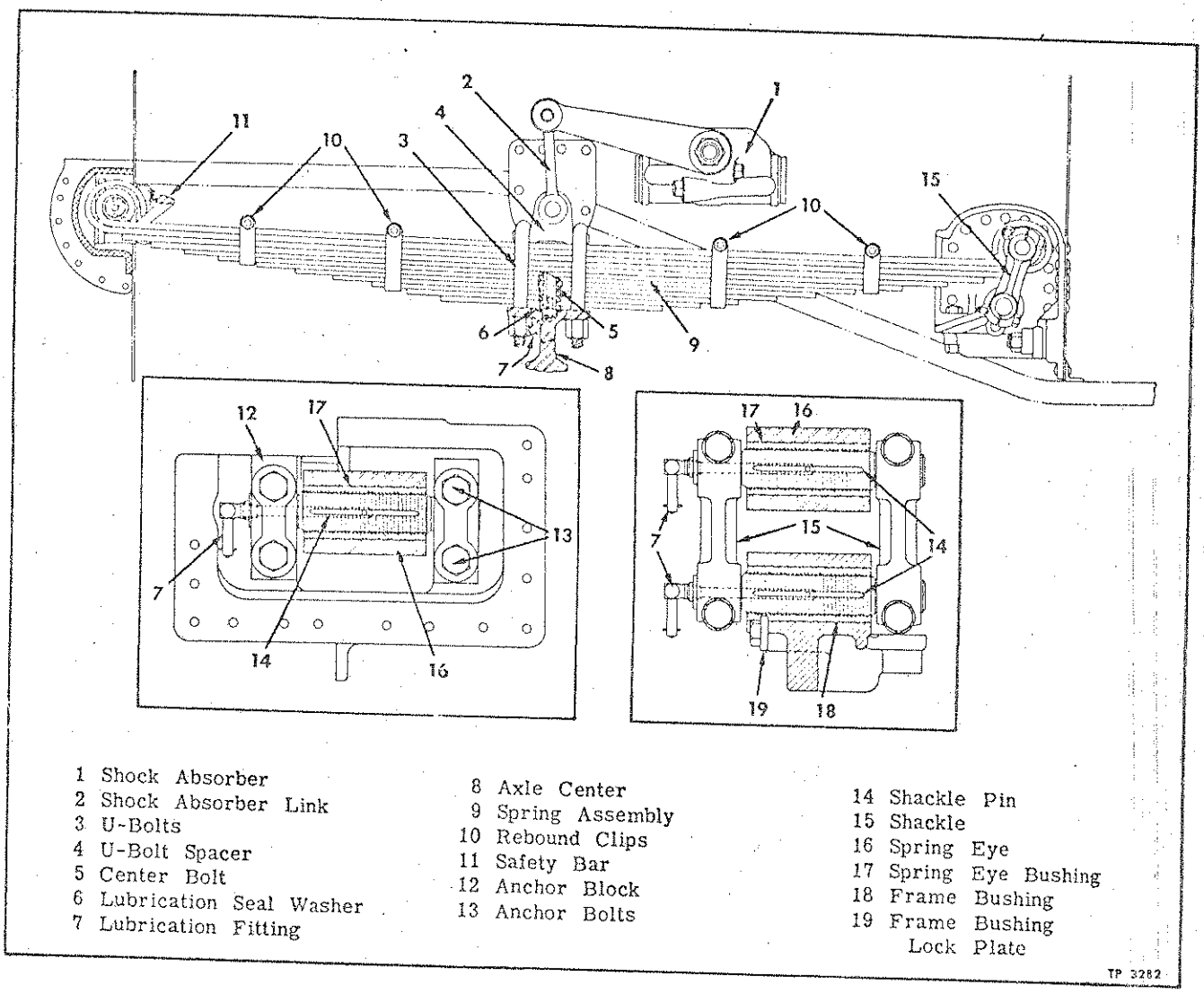


Figure 1—Front Spring Mounting and Shock Absorber Installation

SPRING REPLACEMENT

If spring assemblies have taken a "set," that is, lost their resilience or elastic properties, it is recommended that such springs be replaced with new springs rather than attempting to restore camber by heating, bending, and tempering.

SPRING REMOVAL

After shock absorber link (front springs) and sway bar link (rear springs) have been disconnected at axle, front or rear spring assemblies may be removed in the following manner:

1. Block wheels of vehicle to prevent rolling then jack up both sides of end of vehicle, from which spring is to be removed until spring tension is relieved. Jacking up both sides of vehicle will help reduce torsional strain on shackle pins. Place block under end of axle and spring to be serviced.

2. Loosen spring assembly to axle mounting bolt nuts so they may be removed later without difficulty.

3. Remove nuts and lock washers from anchor bolts, drive bolts out of anchor blocks, then remove anchor blocks.

4. Remove all lubrication fittings from shackle pins, then remove nuts and lock washers from all rear spring shackle pins and remove shackle plates. Front spring shackles may be removed after shackle clamp bolts have been removed from shackles.

5. After placing support under spring assembly, to keep spring from dropping on floor, complete removal of spring assembly to axle mounting bolts; thereby disconnecting spring from axle and completing removal of spring. Remove and discard lubrication seal washer (6, fig. 1).

SPRING INSTALLATION

Spring center bolt is located forward of spring center on both front and rear spring assemblies, as shown in "Specifications" at end of this section.

In order to insure correct positioning of axles, it is imperative that spring assemblies be installed with longer portion of spring rearward of axle.

FRONT SPRINGS

1. Install new lubrication seal washer (6, fig. 1) in recess in axle center, position spring on I-beam of front axle correctly, place U-bolt spacer on spring, then install U-bolts, tightening nuts securely.

2. Place shackles on rear shackle pins, making sure milled slots in pins are lined up with clamp bolt holes in shackles, then install shackle clamp bolts, lock washers, and nuts.

3. Position anchor blocks on front shackle pin, making sure milled slots in pin are lined up with anchor bolt holes in anchor block. Place anchor bolts in anchor blocks, position safety bar on anchor bolts, then install lock washers and nuts on anchor bolts.

4. Connect shock absorber link to U-bolt spacer, tighten link stud nut securely then back off nut just enough to install new cotter pin.

5. Install lubrication fittings in inner ends of all shackle pins and in opening in front axle.

6. Tighten all nuts and bolts as directed, previously, under "General Spring Maintenance" in this section.

REAR SPRINGS

1. Position spring under rear axle housing, correctly, then install spring retainer assembly and mounting bolts, tightening nuts securely.

2, Position anchor blocks on rear shackle pin, making sure milled slots in pin line up with anchor bolt holes in anchor blocks, then install anchor bolts, lock washers, and nuts.

3. Place shackle plates on front shackle pins and secure with new lock washers and nuts.

4. Connect sway bar link to spring retainer bracket, tighten link stud nut securely, then back off nut just enough to install new cotter pin.

5. Install lubrication fittings in inner ends of all shackle pins and in adapter on end of center bolt.

6. Tighten all nuts and bolts as directed, previously, under "General Spring Maintenance" in this section.

SPRING OVERHAUL

If it becomes necessary to replace a broken spring leaf, broken rebound clip, or a worn spring eye bushing; spring must be removed from vehicle and disassembled.

DISASSEMBLY

1. Clamp spring leaves firmly together, using one C-clamp on each side of center bolt, then remove rebound clip nuts, bolts and spacers. If a rebound clip is badly damaged, cut off rivet head to remove clip from spring leaf.

2. Remove lubrication fittings from ends of shackle pins, then remove center bolt from spring. Remove C clamps, releasing spring tension slowly to avoid possible injury.

3. Place wrench on hex-head end of shackle pins and back threaded pins out of spring eye bushings.

4. Press spring eye bushings out of spring eyes; use arbor press and suitable bushing removing tools.

5. Bushings are used in frame at rear shackle end of springs only. To remove frame bushing, first remove lock bolt and lock plate; then drive bushing out of frame. NOTE: Rear spring frame bushing lock bolts are safety-wired to prevent accidental loosening.

CLEANING AND INSPECTION

1. Clean all rust and dirt from spring leaves, using a wire brush, then inspect leaves for cracks or breaks. Replace leaves that are cracked or broken.

2. Clean out oil passages in shackle pins and wash old grease and dirt from lubrication fittings. Be sure all lubricant passages are clean.

3. Check spring eye bushings and shackle pins for excessive wear and replace if necessary. Refer to "Specifications" at end of this section.

4. Examine shackle plates, shackles, anchor bolts, center bolt, rebound clips, rebound clip bolts, anchor bolts, and U-bolts for evidence of wear or failure. Replace any parts that are unfit for further service.

SPRING ASSEMBLY

1. Install spring eye bushings, use arbor press and suitable bushing driver. Make sure bushing is aligned with hole in spring eye before attempting to press bushing into place. NOTE: Ends of bushings should be flush with sides of spring eyes as shown in figures 1 and 2.

2. Apply a coating of lubricant specified in Lubrication (Sec.13, of this manual) to spring leaves, stack spring leaves in correct order, then align the center bolt hole. Place assembly in arbor press, or use two C-clamps to compress leaves, then install center bolt. Center bolt should be installed as shown in figures 1 and 2.

3. Install rebound clips. If any rebound clips were removed from spring leaves, these should be riveted to leaves using rivets of same size as those removed. When bottoms of rebound clips are secured to spring leaves, install rebound clip

SPRING SUSPENSION

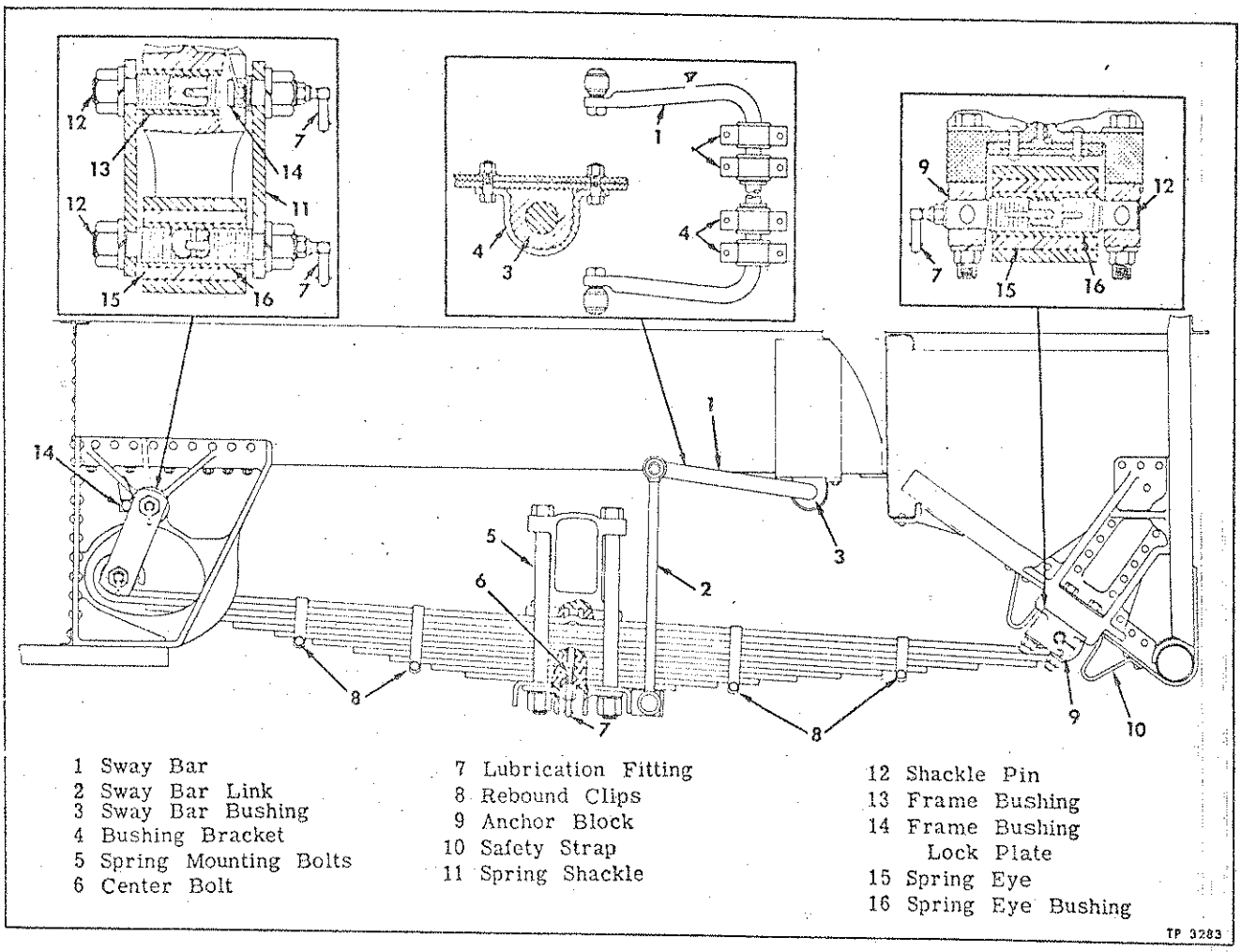


Figure 2—Rear Spring Mounting and Sway Bar Installation

bolts, spacers, and nuts. Tighten nuts just enough to hold leaves in alignment, without restricting free movement of leaves.

4. Dip shackle pins in chassis lubricant then thread pins into spring eye bushings and frame bushing with holes for lubrication fittings positioned as shown in figures 1 and 2. NOTE: Ends of shackle pins should protrude an equal distance on both ends of spring eye bushings.

5. Install frame bushing. Align bushing with hole in frame bracket, with the lock notch in bushing at proper angle, then drive in place using suitable bushing driver. Install and tighten lock plate, lock plate bolt, new lock washer, and nut.

SWAY BARS

To minimize road shocks and swaying of rear end of vehicle, rubber mounted sway bars have been installed on rear of vehicle. Transverse section of sway bar is mounted in four rubber bushings and is attached to coach side rail support brackets with four U-shaped clips as shown in figure 2. Arms of sway bar extend toward front of vehicle and are connected to spring retainer plate assembly with rubber bushed link arms.

Unsatisfactory sway bar action and noise may be caused by worn joints in link between spring retainer plate and sway bar arms. To determine if and where worn condition exists, disconnect link and check for looseness in joint at both ends of link. Links are so constructed that, if joints are worn, new links must be installed.

SUPPORT BUSHING REPLACEMENT

If it becomes necessary to replace rubber support bushings, proceed as follows:

1. Jack up rear of vehicle to relieve spring tension then disconnect sway bar links from spring retainer plate assembly.

2. Disconnect sway bar links from sway bar arms. Remove bolts attaching U-shaped clips and sway bar cross-member to frame side rail support brackets.

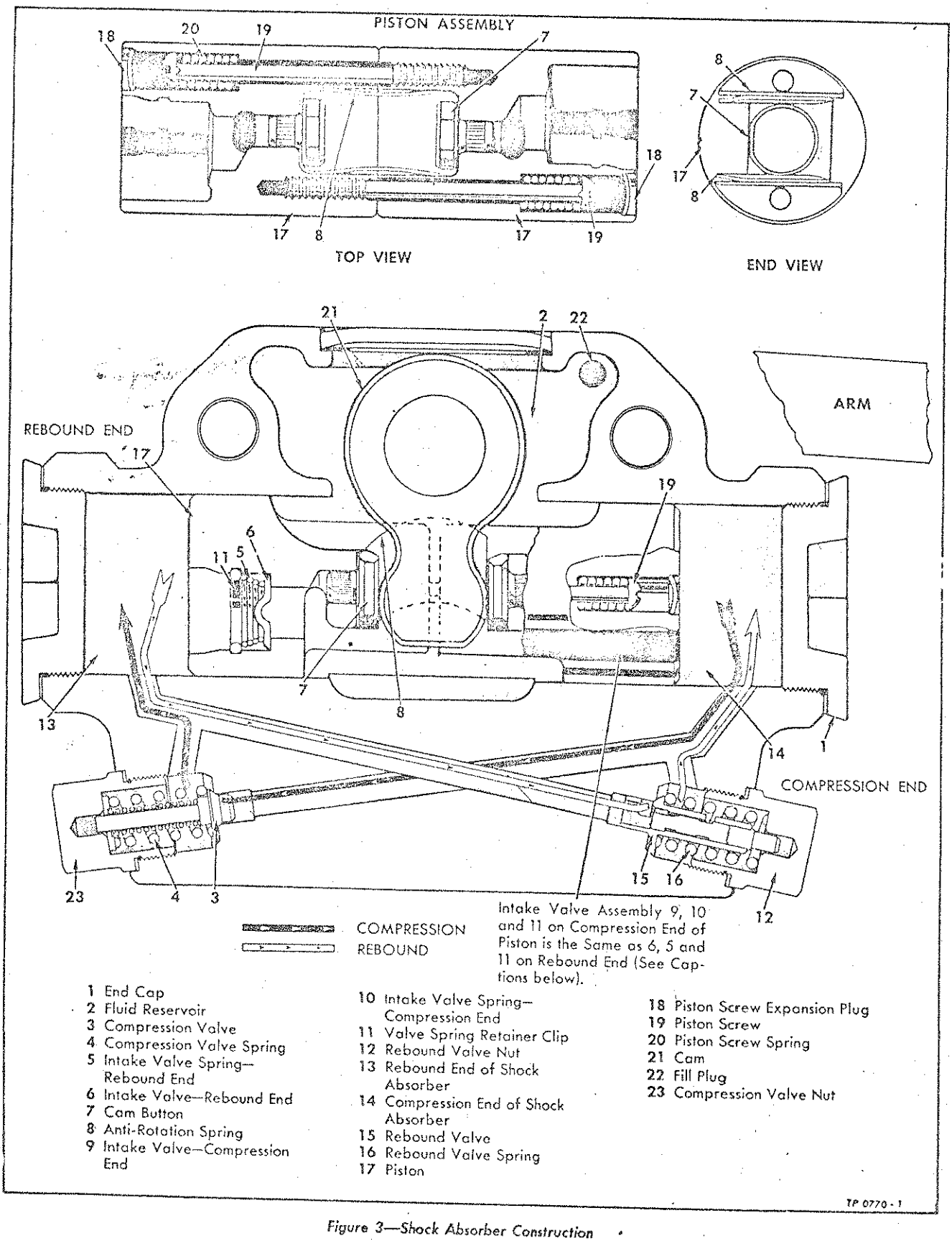


Figure 3—Shock Absorber Construction

SPRING SUSPENSION

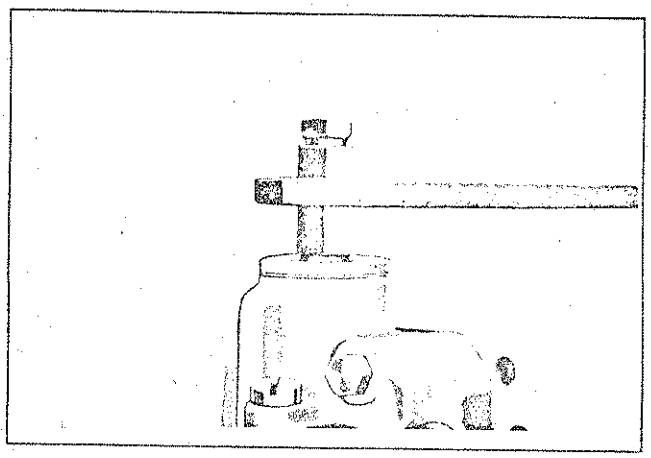


Figure 4—Removing Shock Absorber End Cap

3. Slip worn bushings off over ends of sway bar cross-member.

4. Coat new rubber bushings with hydraulic brake fluid then slide bushings into place over ends of sway bar cross-member.

5. Reinstall sway bar and linkage, reversing steps listed previously for removal. Always use new cotter pins when reinstalling linkage and be sure eye of sway bar is properly seated on tapered stud in joint.

SHOCK ABSORBERS

Shock absorbers are double acting hydraulic type, interconnecting frame and axle through links (fig. 1), and are used at front springs only.

Shock absorber sectional view, showing direction of fluid flow during spring compression and rebound, is shown in figure 3.

MAINTENANCE

Units should be inspected, links tightened and fluid level checked at regular intervals. Valves of proper spring strength and orifice size have been selected to give the best possible performance and should not be changed under ordinary conditions.

While units are constructed so as to permit overhauling in the field, this operation requires special tools and equipment. If facilities are not available to do this work, shock absorbers may be taken to any GMC Service Station for repair or complete overhaul. Shock absorbers should be overhauled, approximately every 50,000 miles. Before proceeding with any repair operation, be sure tires are properly inflated according to tire manufacturer's recommendations. Smooth operation is obtained only when spring shackles operate freely and tires are correctly inflated.

FLUID

When refilling units with fluid, use only fluid

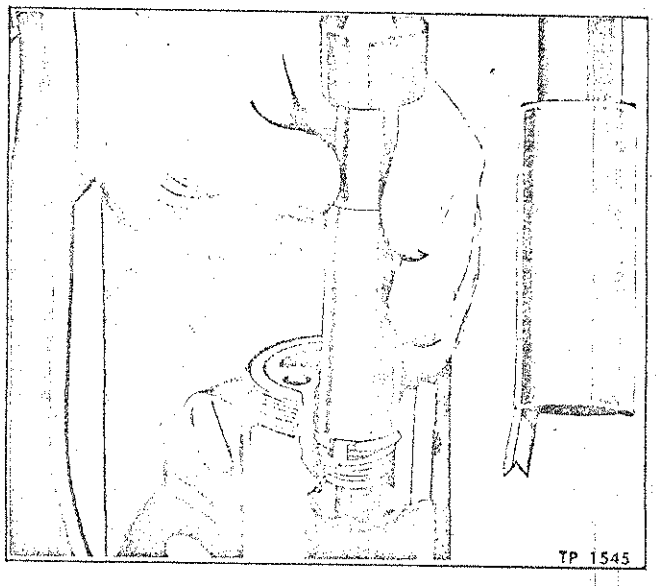


Figure 5—Installing Valve Spring Retainer

recommended in Lubrication (Sec. 13, of this manual. This fluid is non-corrosive and has only a slight change in viscosity over a wide range of temperatures.

Testing

Disconnect link from spring and pull shock absorber arm down. If arm drops easily part way, then stops and continues moving down slowly, there is not enough fluid in unit.

Filling

Clean exterior of unit then remove filler plug. Fill with correct fluid to bottom of filler plug hole. Replace filler plug and move shock absorber arm up and down to work fluid into piston cylinder, then add enough fluid to fill reservoir. To provide necessary air space, allow fluid to escape down to lower edge of filler plug hole before replacing plug. If leaks are evident around end cap, valve plug, or filler plug, replace gaskets.

Packing washers on shock absorbers which have been operating with fluid below proper level, may become worn, causing leaks around shaft. Leaks of this nature require replacement of unit.

REPLACEMENT

Removal

While shock absorber can be removed with wheel in place, removal of wheel will make shock absorber more accessible. Disconnect link from shock absorber arm. Disconnect unit from frame side rail, and remove from vehicle.

Installation

Reverse removal procedures. When installation is complete, tighten all screws and nuts, then paint unit and fittings.

MAJOR OVERHAUL

If shock absorber body or arm is broken, arm is "frozen," absorber leaks at arm, or there is no resistance in unit when arm is moved and unit is full of fluid; then shock absorber should be overhauled.

DISASSEMBLY (Fig. 3)

1. Remove dirt, grease, and loose paint from exterior.
2. Remove unit from vehicle and place in vise, being careful to clamp vise so as not to cause a bind on pistons.
3. Remove filler plug, drain fluid completely; then remove end caps (with special tool No. J-767, on front shock absorbers).
4. Remove relief valve nuts (12 and 23), rebound valve (15), compression valve (3) and intake valves (6 and 9). To remove intake valves, first remove valve spring retainer clip with a screw driver; then lift valves out.
5. Remove plugs (18) over piston screws (19), then disassemble piston (17).
6. Wash all parts in kerosene then inspect for wear. Blow out valve orifices with compressed air until clean.
7. Check camshaft for wear in housing by moving shock absorber arm sideways. If shaft is "galled" or worn, replace complete shock absorber.

ASSEMBLY (Fig. 3)

1. Assemble piston. Try both sizes of piston in cylinder. Use size which allows some clearance otherwise binding and noise will result. Position piston and anti-rotation spring (8) as shown in figure 3.
2. Tighten piston screws firmly then back off one to one and a half turns to prevent binding between cam (21) and cam buttons (7), then install new plugs over piston screws.
3. Replace intake valves and valve spring retainer clips using tool No. J-896-A.
4. Replace rebound valve (15), valve nut (12), compression valve (3), and valve nut (23). Use new gaskets.
5. Install one end cap (using new gasket) then rotate unit and fill to capacity with fluid. While filling, move arm to expel air from fluid.
6. Install other end cap then fill unit as previously directed under "Fluid," in this section.

NOTE: Shock absorber body, arm, packing gland, camshaft, and cam are not replaceable due to special fixtures and presses required to assemble and disassemble these parts.

SHOCK ABSORBER LINKS

Links are used between shock absorber arm and axle as shown in figure 1. Unsatisfactory shock absorber action and noise may be caused by worn joints in links. To determine if and where worn condition exists, disconnect link and check for looseness in joints at both ends of link. If joints are worn, new links must be installed.

SPECIAL TOOLS

Reference is made to special tools in this section. These tools, or their equivalent, are necessary and are recommended to more readily accomplish certain service operations. Names and addresses of vendors are listed, and any information regarding availability, price, etc., should be obtained directly from them.

Tool No.	Tool Name
J-767	Shock Absorber (Hexagon)End Cap Wrench
J-896-A	Shock Absorber Valve Installing Tool

Vendor	Address
Kent-Moore Organization	Detroit, Michigan

SPRING SUSPENSION

SPECIFICATIONS

FRONT SPRINGS

Leaves	
No. of Leaves	12 or 13
Thickness	
12 Leaf Spring	2 @ 7/16"; 4 @ 3/8"; 5 @ 11/32"; 1 @ 5/16"; 4 13/32"
13 Leaf Spring	1 @ 13/32"; 1 @ 3/8"; 11 @ 5/16"; 4 7/32"
Width	4"
Length (When Loaded)	
Center to Center of Spring Eyes	58 3/4"
Center of Front Eye to Seat Center	28 1/4"
Center of Rear Eye to Seat Center	30 1/2"
Rebound Clips	4

REAR SPRINGS

Leaves	
No. of Leaves	13
Thickness	
Either	3 @ 17/32"; 9 @ 15/32"; 1 @ 7/16"; 6 1/4"
Or	1 @ 17/32"; 4 @ 1/2"; 8 @ 7/16"; 6 1/32"
Width	4"
Length (When Loaded)	
Center to Center of Spring Eyes	73 1/2"
Center of Front Eye to Seat Center	35 1/2"
Center of Rear Eye to Seat Center	38"
Rebound Clips	4

SPRING BUSHINGS

Outer Diameter	
New	1.762" - 1.765"
Service	1.794" - 1.797"
Length	4"
Thread	1 3/8" - 6 - U.S.F. Tap
Pitch Diameter	1.2635" - 1.2695"

SHACKLE PINS

Rear Spring Front	
Thread	1 3/8 - 6 A.N.C. Tap
Pitch Diameter	1.2395" - 1.2435"
All Others	
Thread	1 3/8 - 6 U.S.F. Tap
Pitch Diameter	1.2395" - 1.2435"

SHOCK ABSORBERS

Make	Delco Product
Type	Double Acting
Model	
Right Front	1696 - E - 3B - D2
Left Front	1696 - F - 3B - D2

Steering Gear

Contents of This Section

Related Subjects in Other Sections

The steering mechanism comprises the steering gear assembly, connecting linkage and allied parts of the front axle. The steering gear assembly is connected to steering arm at left hand steering knuckle through the Pitman arm and drag link. Front axle parts, pertinent to steering, are covered in Front Axle (Sec. 1B. of this manual).

Steering gear, figure 2, is cam and roller twin lever type. The only contact between actuating and actuated members of gear is rolling-line-contact between lever studs and cam thread. Clearance between studs and cam can be adjusted by means of adjusting screw and lock nut, accessible from under vehicle, as described under "Steering Gear Adjustments" in this section.

CONSTRUCTION AND OPERATION

The essential operation of the gear is same as conventional type gear except steering effort is transmitted to steering gear proper by means of bevel gears and a universal jointed shaft. The two lever shaft studs, in steering gear proper, are designed to operate in such a manner as to give effective steering with a minimum of steering effort. Cam grooves are cut shallower in straight ahead driving position of each stud to produce a high point in the groove (equal at each stud) that causes closer mesh of studs in groove through mid-position of travel of each stud. At points other than straight ahead driving position, more clearance is provided for studs to allow free action. This feature permits compensation for wear, by adjusting studs into grooves after such wear has occurred at "high point," without causing studs to bind at other points in grooves. Groove sides are cut on a uniform angle designed to fit against stud taper in any position. Thus, it will be seen that varying depth of groove makes for what might be termed a high range of support at those points where groove is shallower. In this manner a very sensitive adjustment is permissible.

Lever shaft is mounted in two bushings located in gear housing. An oil seal assembly is provided at Pitman arm end of lever shaft.

The cam is integral with lower steering shaft, and is mounted in gear housing between two ball bearing assemblies. Lower bearing is adjustable towards upper bearing for removing cam and shaft end play. Ball bearing assembly, pressed into steering column jacket, supports upper end of steering shaft. Lower end of steering shaft is mounted in a single row ball bearing assembly retained in bevel gear housing.

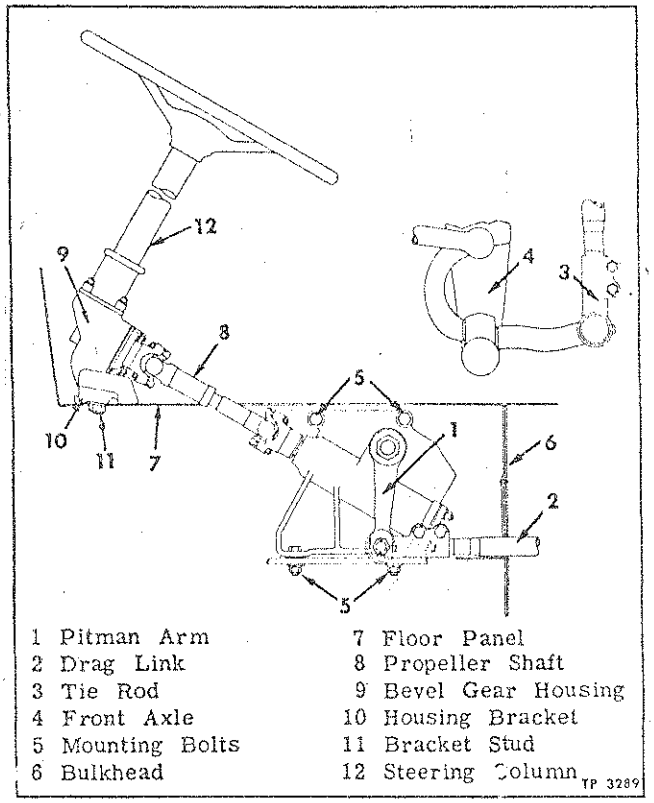
MOUNTING

Steering gear and drag link installation views are shown in figure 1. Steering gear assembly is attached to vehicle understructure by mounting bolts which hold the steering gear housing in place, and is accessible for adjustments or replacement through tool compartment door.

Bevel gear housing is bolted to bevel gear housing bracket which is riveted to coach floor. Lower end of steering column jacket is riveted to bevel gear housing, upper end is retained in steering column gear shift housing assembly. Steering column gear shift housing consists of two pieces; the gear shift housing which is bolted to instrument panel supports, and the housing cap which is bolted to housing. Removal of housing cap, permits removal of steering column without disturbing gear shift controls, and also provides means of correcting steering column misalignment.

Steering gear universal joint is housed under steering gear removable cover and is accessible for inspection or removal after cover is removed.

STEERING GEAR



1 Pitman Arm	7 Floor Panel
2 Drag Link	8 Propeller Shaft
3 Tie Rod	9 Bevel Gear Housing
4 Front Axle	10 Housing Bracket
5 Mounting Bolts	11 Bracket Stud
6 Bulkhead	12 Steering Column

TP 3289

Figure 1—Steering Gear Installation Views

INSPECTION AND LUBRICATION

The following light maintenance operations include items which should be periodically inspected and minor repairs and adjustments which may be accomplished without removing the steering gear from the vehicle.

1. At regular intervals check and tighten, if necessary, all steering gear mounting bolts, Pitman arm retaining nut, and housing side cover attaching bolts.

2. Inspect drag link and steering gear adjustments and adjust if necessary. Refer to "Steering Gear Adjustments," covered later in this section, for method of checking steering gear adjustment and refer to "Steering Drag Link" for drag link information.

3. Lubricate steering gear and allied units as directed in Lubrication (Sec. 13, of this manual).

STEERING GEAR ADJUSTMENTS

Before an attempt is made to remedy steering difficulties by adjusting steering gear, other factors which might cause hard or otherwise unsatisfactory steering should be checked. Reference should be made to Trouble Shooting (Sec. 21 in this manual), for steering gear trouble diagnosis and remedial measures. It is important that steering gear be properly adjusted to assure satisfactory steering and prevent excessive wear of parts. Adjustments for thrust of ball bearings on cam, for minimum backlash of tapered lever shaft studs in cam groove, for bevel gear backlash; are provided. Always check cam bearing adjustment, and adjust if necessary, prior to making lever shaft backlash adjustment. Before making adjustments, following preliminary operations are necessary:

1. Disconnect steering drag link from Pitman arm so that steering gear will be free of all load. Note relative positions of parts. Link should remain disconnected until all adjustments are completed.

2. Tighten steering gear housing to under structure mounting bolts.

CAM BEARING ADJUSTMENT (Fig. 2)

Before making this adjustment, loosen the lever shaft thrust adjusting screw (8, fig. 2) to free the studs in the cam groove, then proceed as follows:

1. Loosen four gear housing lower cover to housing stud nuts ther move housing cover (12) until shims (11) are accessible.

2. Shims are of .002,, .003, and .010 inch thickness. Clip and remove one of the thinner shims, then tighten four cover nuts securely.

3. Test adjustment. Cam bearing adjustment is correct when a barely perceptible drag is felt when steering wheel is turned, while gripped lightly at rim, with thumb and forefinger. If steering wheel will not turn freely, adjustment is too tight.

4. If adjustment is still not correct, remove or replace shims until correctly adjusted.

NOTE: If it is necessary to install new shims to obtain correct cam bearing adjustment, shims may be cut in half and inserted between other shims temporarily. Be careful, however, that ends of shim do not overlap and that half-shims do not drop out while tightening cover nuts. Shims installed in this manner must always be replaced by whole shims at earliest opportunity.

LEVER SHAFT THRUST ADJUSTMENT (Fig. 2)

Since larger portion of driving is done when traveling in an approximately straight line, more wear occurs in steering gear within about one-quarter wheel turn either side of straight-ahead position. For this reason, within this range, width of cam groove is narrower than elsewhere, making it possible to adjust gear for wear without binding in extreme positions. It is important to note that lever shaft thrust must be adjusted with lever shaft in position where width of cam groove is narrowest; that is within one half wheel turn of straight-ahead driving range.

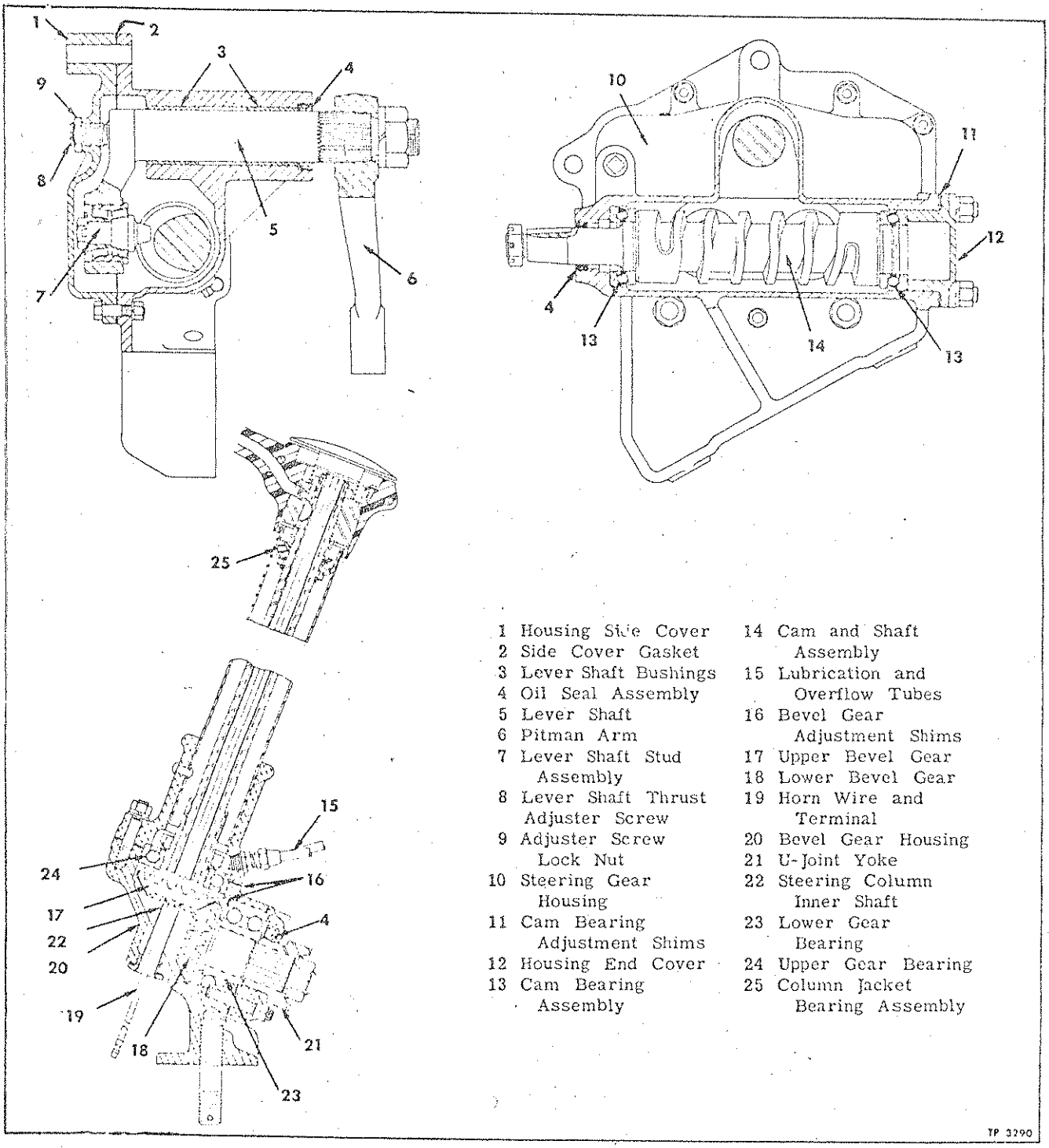


Figure 2—Steering Gear Construction

Lever shaft thrust adjustment is made by means of adjusting screw, (8) located in side cover at inner end of lever shaft. Be sure cam bearings are adjusted properly, then proceed as follows:

1. To gain access to lever shaft adjuster screw, remove driver's seat, then remove air duct cover, air duct cover seal, and elbow turn assembly from air duct.

2. Disconnect steering drag link at Pitman arm.

3. Center steering gear by turning steering

STEERING GEAR

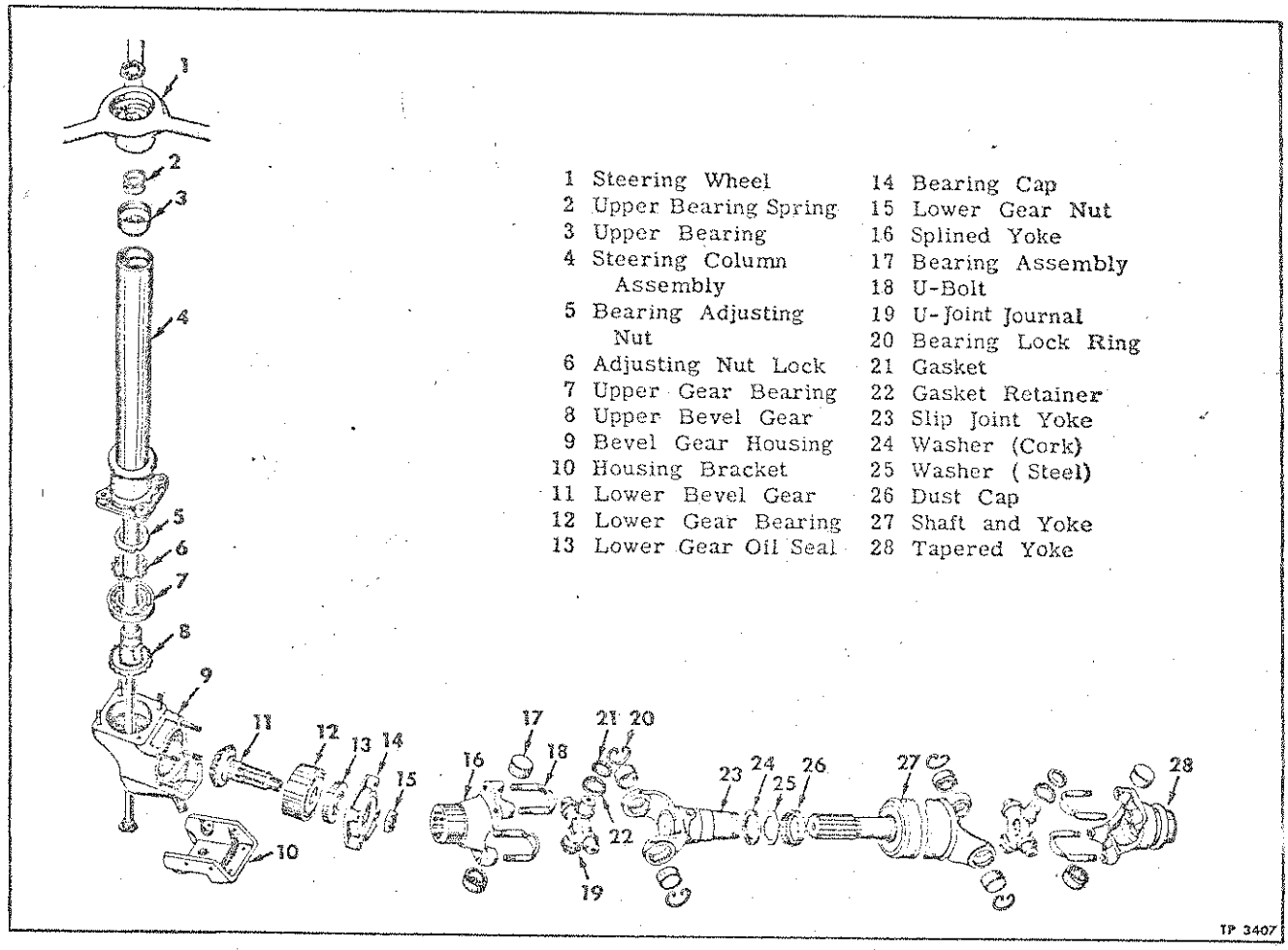


Figure 3—Steering Column and Propeller Shaft Components

wheel from right or left extreme, carefully counting number of turns, then rotate wheel back exactly halfway. Mark wheel at top or bottom center with a piece of tape.

4. Loosen lock nut (9) on adjusting screw (8), then tighten adjusting screw until all lever shaft thrust is removed.

5. Back off adjusting screw until only a very slight drag is felt through the mid-position when turning steering wheel slowly from one extreme position to the other.

6. Tighten lock nut securely and again test adjustment to make sure that lever shaft thrust did not change when lock nut was tightened. Connect steering drag link to Pitman arm.

When steering gear is properly adjusted, lever shaft will have slight amount of thrust. This is necessary to insure proper lubrication, because film of lubricant must separate lever studs and walls of cam groove at all times or rapid parts wear will result. A closer adjustment will not correct any steering condition, but will serve only to damage and wear parts and impair operation.

ADJUSTING BEVEL GEAR BACKLASH (Fig. 2)

Proper adjustment of bevel gears (17 and 18) must be maintained to assure correct gear contact and normal function of the gears and bearings. Upper bevel gear (17) is mounted on single row ball bearing (24) which is retained with a special lock nut and lock washer. Lower bevel gear (18) is mounted on double row ball bearing (23); the inner race of which is fixed by shoulder of gear and universal joint yoke; the outer race is bearing cap and shoulder of housing.

During the adjustment, gears should be revolved to make sure that there are no "high spots" or bind in gears. If gears are adjusted too tight, the resulting bind will cause hard steering and excessive load on bearings; also, if gears are adjusted too loose, operation will be rough and noisy.

Upper bevel gear is adjusted by adding or removing shims (16) between upper bearing cap and bevel gear housing (20). Bevel gear housing is accessible after steering gear removable cover assembly has been removed.

Lower bevel gear is adjusted by adding or removing shims (16) between inner side of double row ball bearing outer race and bevel gear housing.

Adjust until there is no perceptible backlash between gears. Add shims to increase backlash remove shims to decrease backlash.

ADJUSTING STUD-ROLLER BEARING UNITS

The foregoing adjustments will suffice in nearly every instance, but in some cases it may be necessary to adjust stud roller bearing units in lever shaft, in which case steering gear must be removed from chassis and disassembled in order to make lever shaft accessible. Refer to "Steering Gear Overhaul," later in this section for steering gear removal and disassembly procedures.

The roller bearings should be preloaded at all times. Adjust to a heavy drag. Used units should be set lighter than new replacement units but never below a minimum stud turning torque of 5 to 11 inch-pounds. Factory adjustments on new units are within these limits.

Stud roller bearing adjustment may be accomplished as follows: (Key numbers refer to fig. 7)

1. Wash stud bearings (9) in kerosene and lubricate with light oil.

2. Place lever stud (8) in vise with nut (4) up, taking care to grip straight cylindrical portion only. Extreme care should be exercised to prevent damage to stud bearing surfaces.

3. Straighten out prong of lock washer (5). Tighten stud nut (4) securely then back off nut slightly. Tap both sides of lever shaft (10) with soft metal hammer to seat bearings (9) properly.

4. Rotate stud (8) back and forth and test adjustment.

5. When adjustment is within correct limits, lock adjustment by bending prong of lock washer (5) against a side of the nut (4). Bend the prong that is at right angle to a side of the nut. DO NOT USE A LOCK WASHER TWICE UNLESS PRONGS USED BEFORE HAVE BEEN REMOVED.

6. Lubricate stud assembly with steering gear lubricant specified in Lubrication (Sec. 13 of this manual).

STEERING GEAR OVERHAUL

Whenever, due to excessive wear, the steering gear assembly cannot be adjusted properly, or if during adjustment, "lumpy" or rough action is noticed, it will be necessary to overhaul the steering gear assembly. The steering gear should be removed from vehicle for all overhaul or repair operations.

STEERING GEAR REMOVAL (Fig. 3)

1. Remove driver's seat, then remove steering gear removable cover assembly and cover seal.

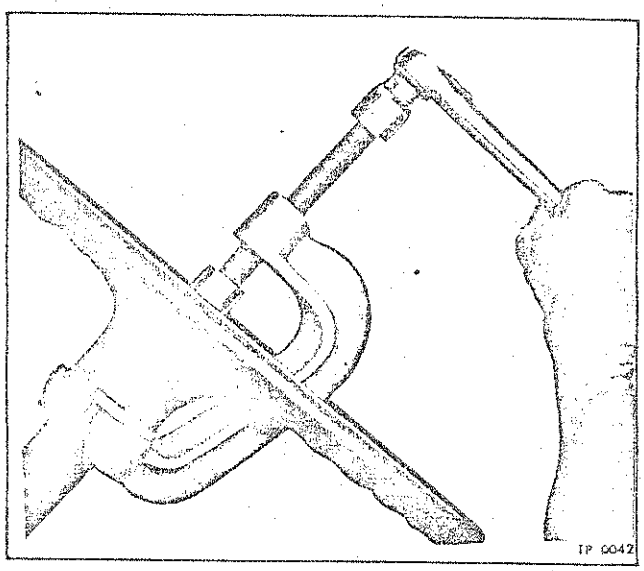


Figure 4—Removing Steering Wheel—Using Tool No. J-452-G (Typical)

2. Depress horn button and turn to left to disengage lugs on button from base plate assembly. Remove horn button, horn contact cup, contact spring, and contact cap. Remove screws which attach base plate assembly to steering wheel, then remove base plate assembly and spring.

3. Remove steering wheel retaining nut, then, using steering wheel puller (Tool No. J-452-G) as illustrated in figure 4, pull wheel off upper steering shaft and remove key from keyway in upper shaft.

4. Remove four cross-recess screws which bolt steering column gear shift housing cap to housing assembly, then remove housing cap.

5. Disconnect universal joint, at bevel gear housing, by removing U-bolts (18) which attach journal (19) of joint to splined yoke (16).

6. Disconnect lubrication and overflow tubes (15, fig. 2) at bevel gear housing.

7. Remove left hand fog light as directed in Lighting (Sec. 7G in this manual), then, working through fog lamp opening, remove cotter pin and nut from stud which attaches bevel gear housing to vehicle floor.

8. Disconnect horn wire from socket, then remove column assembly from vehicle.

9. Steering gear housing is accessible through tool compartment, as shown in figure 5. Working through tool compartment door, disconnect steering drag link from Pitman arm, as directed under "Steering Drag Link," later in this section.

10. Disconnect universal joint, at steering gear housing, by removing U-bolts which attach U-joint journal to tapered yoke (28). Remove steering gear propeller shaft.

STEERING GEAR

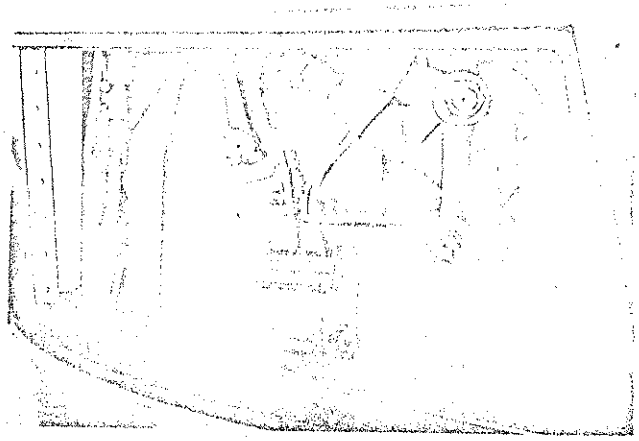


Figure 5—Steering Housing Accessibility

11. Remove four steering gear housing to vehicle understructure attaching bolts (5, fig. 1), then remove housing through tool compartment door.

12. Remove Pitman arm retaining nut and lock washer. Note aligning marks on Pitman arm and lever shaft. If marks are not clearly discernible, punch mark both parts, then remove Pitman arm using a suitable puller.

NOTE: Pitman arm may be removed from lever shaft while steering gear is installed in vehicle if so desired.

STEERING GEAR DISASSEMBLY

Prior to disassembly operations, be sure that steering gear, work bench and tools are clean. Steering gear parts must be kept free from dirt. When mounting steering gear in vise or other holding fixture, do not grip housing too tightly or housing may be damaged.

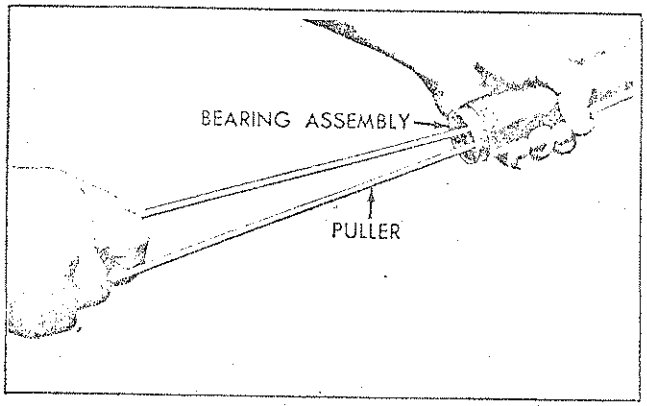


Figure 6—Removing Upper Jacket Tube Bearing —Using Tool No. J-489

COLUMN DISASSEMBLY (Fig. 3)

1. Remove nuts and lock washers from studs which attach steering column assembly (4) to bevel gear housing (9) then remove column assembly.

2. Remove upper bearing (3) from steering column assembly (4), using tool No. J-489 as shown in figure 6.

3. Remove bearing adjusting nut (5), adjusting nut lock (6), and upper gear bearing (7) from steering shaft, then pull steering shaft and upper bevel gear (8) out of bevel gear housing (9).

4. Remove cotter pin and lower gear nut (15) from lower bevel gear (11), then remove splined yoke (16) from lower bevel gear.

5. Remove nuts and lock washers from bevel gear housing studs, then remove bearing cap (14) and gasket. Press lower gear oil seal (13) out of bearing cap.

6. Using suitable tool, remove lower gear bearing (12) from gear housing, then remove lower bevel gear (11). Remove all old adjusting shims (16) from housing.

7. If necessary, horn wire tube may be removed after tube bushing has been removed from bottom of bevel gear housing.

HOUSING DISASSEMBLY (Fig. 7)

1. Remove lock nut (1) and turn lever shaft adjusting screw (2) out a few turns.

2. Place pan under assembly to catch lubricant, then remove gear housing side cover (3) and side cover gasket.

3. After lubricant has drained out of housing, slide lever shaft assembly (10) out of housing, first being sure outer end of lever shaft is free from any burrs which might damage housing bushings as shaft is withdrawn.

4. Disassemble lever shaft assembly. Bend prong of lock washer (5) away from stud nut, (4) then remove stud nut. Remove bearing inner race (6), bearings (9), and stud (8) from bearing outer race (7), then press bearing outer race out of lever shaft.

5. Remove cotter pin and nut which retains universal joint yoke on cam and shaft assembly then remove yoke and woodruff key from shaft.

6. Remove four studs which attach gear housing lower cover to gear housing, then remove lower cover shims and lower cam bearing assembly from gear housing.

7. Press cam and shaft assembly out of gear housing, then remove upper cam bearing assembly housing.

8. Using suitable tool, remove lever shaft oil seal assembly and cam shaft oil seal assembly (13) from gear housing.

CLEANING AND INSPECTION (Figs. 3 and 7)

Clean all parts thoroughly in clean gasoline

STEERING GEAR

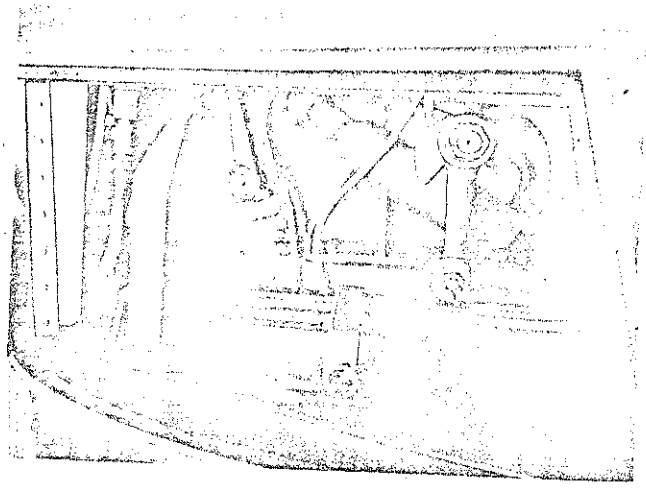


Figure 5—Steering Housing Accessibility

11. Remove four steering gear housing to vehicle understructure attaching bolts (5, fig. 1), then remove housing through tool compartment door.

12. Remove Pitman arm retaining nut and lock washer. Note aligning marks on Pitman arm and lever shaft. If marks are not clearly discernible, punch mark both parts, then remove Pitman arm using a suitable puller.

NOTE: Pitman arm may be removed from lever shaft while steering gear is installed in vehicle if so desired.

STEERING GEAR DISASSEMBLY

Prior to disassembly operations, be sure that steering gear, work bench and tools are clean. Steering gear parts must be kept free from dirt. When mounting steering gear in vise or other holding fixture, do not grip housing too tightly or housing may be damaged.

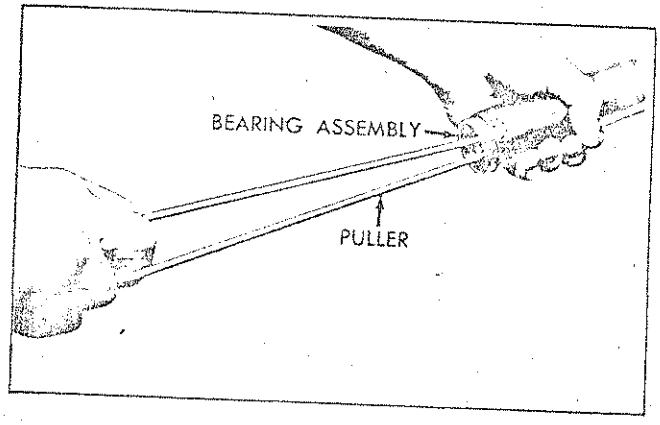


Figure 6—Removing Upper Jacket Tube Bearing —Using Tool No. J-489

COLUMN DISASSEMBLY (Fig. 3)

1. Remove nuts and lock washers from studs which attach steering column assembly (4) to bevel gear housing (9) then remove column assembly.

2. Remove upper bearing (3) from steering column assembly (4), using tool No. J-489 as shown in figure 6.

3. Remove bearing adjusting nut (5), adjusting nut lock (6), and upper gear bearing (7) from steering shaft, then pull steering shaft and upper bevel gear (8) out of bevel gear housing (9).

4. Remove cotter pin and lower gear nut (15) from lower bevel gear (11), then remove splined yoke (16) from lower bevel gear.

5. Remove nuts and lock washers from bevel gear housing studs, then remove bearing cap (14) and gasket. Press lower gear oil seal (13) out of bearing cap.

6. Using suitable tool, remove lower gear bearing (12) from gear housing, then remove lower bevel gear (11). Remove all old adjusting shims (16) from housing.

7. If necessary, horn wire tube may be removed after tube bushing has been removed from bottom of bevel gear housing.

HOUSING DISASSEMBLY (Fig. 7)

1. Remove lock nut (1) and turn lever shaft adjusting screw (2) out a few turns.

2. Place pan under assembly to catch lubricant, then remove gear housing side cover (3) and side cover gasket.

3. After lubricant has drained out of housing, slide lever shaft assembly (10) out of housing, first being sure outer end of lever shaft is free from any burrs which might damage housing bushings as shaft is withdrawn.

4. Disassemble lever shaft assembly. Bend prong of lock washer (5) away from stud nut, (4) then remove stud nut. Remove bearing inner race (6), bearings (9), and stud (8) from bearing outer race (7), then press bearing outer race out of lever shaft.

5. Remove cotter pin and nut which retains universal joint yoke on cam and shaft assembly then remove yoke and woodruff key from shaft.

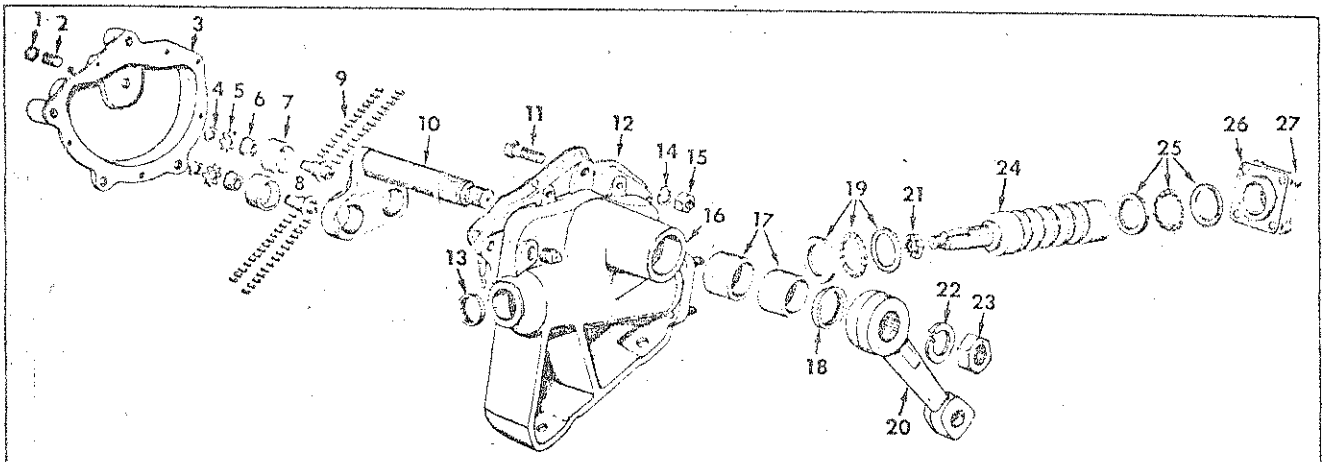
6. Remove four studs which attach gear housing lower cover to gear housing, then remove lower cover shims and lower cam bearing assembly from gear housing.

7. Press cam and shaft assembly out of gear housing, then remove upper cam bearing assembly housing.

8. Using suitable tool, remove lever shaft oil seal assembly and cam shaft oil seal assembly (13) from gear housing.

CLEANING AND INSPECTION (Figs. 3 and 7)

Clean all parts thoroughly in clean gasoline



1 Adjusting Screw Nut	10 Lever Shaft	19 Cam Bearing Assembly
2 Adjusting Screw	11 Side Cover Bolt	20 Pitman Arm
3 Housing Side Cover	12 Side Cover Gasket	21 Cam Shaft Nut
4 Stud Nut	13 Cam Shaft Oil Seal	22 Lever Shaft Washer
5 Bearing Lock Washer	14 Washer	23 Lever Shaft Nut
6 Bearing Inner Race	15 Nut	24 Cam
7 Bearing Outer Race	16 Steering Gear Housing	25 Cam Bearing Assembly
8 Lever Shaft Stud	17 Lever Shaft Bushing	26 Shim
9 Roller Bearing	18 Lever Shaft Oil Seal	27 Lower Cover

TP 3408

Figure 7—Steering Gear Components

or other suitable cleaning fluid. Soak cam bearing assemblies, column jacket bearing assembly, and lever shaft stud bearings in cleaner to dissolve any particles of hard grease. When all parts are clean, perform the following inspection operations:

1. Inspect cam bearings for excessive wear, pitted balls, or broken or damaged retainers. If any of these conditions are present, in an aggravated state, replace cam bearing.

2. Examine stud roller bearings for pitting, chips, or broken rollers. If any rollers have to be replaced, it will be necessary to replace the complete set of rollers. Satisfactory operation cannot be obtained if old and new rollers are installed in the same assembly.

3. Check helical cut grooves of cam and shaft for roughness. Grooves must be smooth and free from scores. Check shaft for bent or sprung condition.

4. Conical contact surfaces of lever shaft studs which ride in cam grooves, must be smooth and round. However, small flat spots may be disregarded.

5. Check action of column jacket bearing assembly. If action is unsatisfactory, or bearings show signs of wear, or retainers are damaged; new bearing assembly should be installed.

6. Lever shaft and Pitman arm should be inspected to make sure they are not bent or twisted and that splines are in good condition.

7. Insert lever shaft in gear housing and check clearance between shaft and housing bushings. If clearance is excessive and diameter of lever shaft is within limits given in "Specifications," at end of this section, bushings should be replaced. When installing new bushings, press bushings into housing until they are positioned as shown in figure 2.

8. Check action of universal joint. If action is not smooth and free, universal joint should be disassembled, cleaned, and inspected for defective parts which would impair action.

9. Inspect gear housing and housing side cover for cracks, distortion, and condition of all tapped holes. Replace parts if unfit for further service.

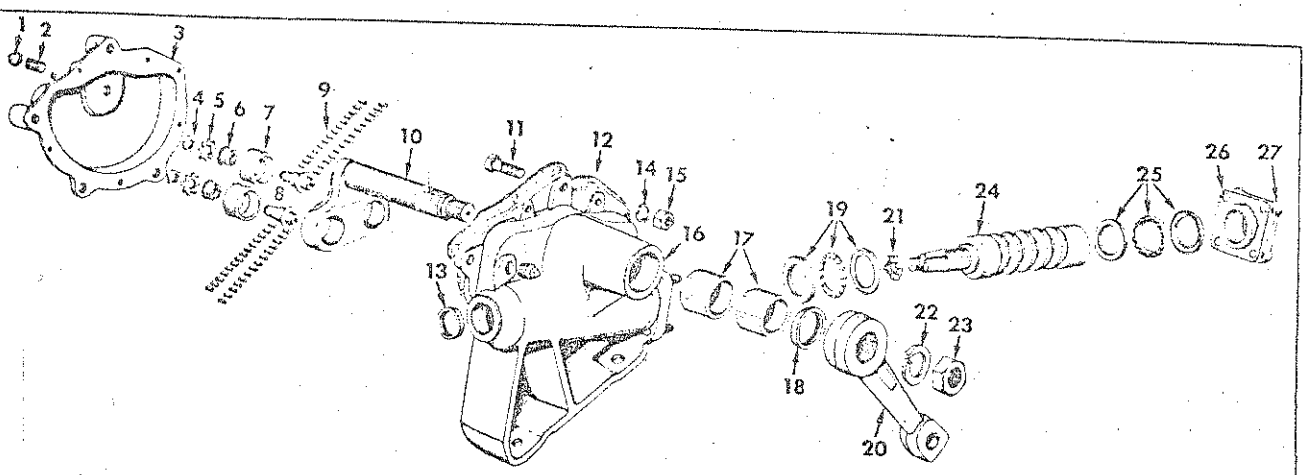
STEERING GEAR ASSEMBLY

Assembly of steering gear parts must not be attempted in dirty surroundings. Parts must be kept absolutely clean since even small particles of dirt, in working parts of steering gear, can cause excessive wear.

HOUSING ASSEMBLY (Fig. 7)

1. Insert steel washer and cork washer into gear housing, then press lever shaft oil seal assembly into gear housing until it seats solidly in housing. NOTE: Use of a new oil seal is recommended, but oil seal may be used if in exceptionally good condition.

2. Assemble lever shaft assembly. Press outer



1 Adjusting Screw Nut
2 Adjusting Screw
3 Housing Side Cover
4 Stud Nut
5 Bearing Lock Washer
6 Bearing Inner Race
7 Bearing Outer Race
8 Lever Shaft Stud
9 Roller Bearing
10 Lever Shaft
11 Side Cover Bolt
12 Side Cover Gasket
13 Cam Shaft Oil Seal
14 Washer
15 Nut
16 Steering Gear Housing
17 Lever Shaft Bushing
18 Lever Shaft Oil Seal
19 Cam Bearing Assembly
20 Pitman Arm
21 Cam Shaft Nut
22 Lever Shaft Washer
23 Lever Shaft Nut
24 Cam
25 Cam Bearing Assembly
26 Shim
27 Lower Cover

TP 3408

Figure 7—Steering Gear Components

or other suitable cleaning fluid. Soak cam bearing assemblies, column jacket bearing assembly, and lever shaft stud bearings in cleaner to dissolve any particles of hard grease. When all parts are clean, perform the following inspection operations:

1. Inspect cam bearings for excessive wear, pitted balls, or broken or damaged retainers. If any of these conditions are present, in an aggravated state, replace cam bearing.

2. Examine stud roller bearings for pitting, chips, or broken rollers. If any rollers have to be replaced, it will be necessary to replace the complete set of rollers. Satisfactory operation cannot be obtained if old and new rollers are installed in the same assembly.

3. Check helical cut grooves of cam and shaft for roughness. Grooves must be smooth and free from scores. Check shaft for bent or sprung condition.

4. Conical contact surfaces of lever shaft studs which ride in cam grooves, must be smooth and round. However, small flat spots may be disregarded.

5. Check action of column jacket bearing assembly. If action is unsatisfactory, or bearings show signs of wear, or retainers are damaged; new bearing assembly should be installed.

6. Lever shaft and Pitman arm should be inspected to make sure they are not bent or twisted and that splines are in good condition.

7. Insert lever shaft in gear housing and check clearance between shaft and housing bushings. If clearance is excessive and diameter of lever shaft is within limits given in "Specifications," at end of this section, bushings should be replaced. When installing new bushings, press bushings into housing until they are positioned as shown in figure 2.

8. Check action of universal joint. If action is not smooth and free, universal joint should be disassembled, cleaned, and inspected for defective parts which would impair action.

9. Inspect gear housing and housing side cover for cracks, distortion, and condition of all tapped holes. Replace parts if unfit for further service.

STEERING GEAR ASSEMBLY

Assembly of steering gear parts must not be attempted in dirty surroundings. Parts must be kept absolutely clean since even small particles of dirt, in working parts of steering gear, can cause excessive wear.

HOUSING ASSEMBLY (Fig. 7)

1. Insert steel washer and cork washer into gear housing, then press lever shaft oil seal assembly into gear housing until it seats solidly in housing. NOTE: Use of a new oil seal is recommended, but oil seal may be used if in exceptionally good condition.

2. Assemble lever shaft assembly. Press outer

STEERING GEAR

bearing races (7) into lever shaft (10) with flanged end of races towards Pitman arm end of lever shaft. Coat inside surface of outer race with soft cup grease or vaseline to hold rollers in position during assembly, then install rollers (9), stud (8), inner race (6), lock washer (5), and lock nut (4) in outer race. Adjust as directed previously under "Adjusting Stud Roller Bearing Units."

3. Install upper cam bearing unit in gear housing, making sure upper race seats solidly in housing.

4. Place cam and shaft assembly (24) in gear housing, then press lower cam bearing unit (25) into housing.

5. Place shims (26) over lower cover, position cover on housing, then install four attaching studs using new lock washers. Adjust cam bearing clearance as previously directed under "Cam Bearing Adjustment" in this section.

6. Insert woodruff key in slot in upper end of cam and shaft assembly, position universal joint lower yoke on shaft, then install retaining nut (21) and new cotter pin.

7. Slide lever shaft assembly into gear housing being careful not to nick or score housing bushings or oil seal.

8. Place new side cover gasket on gear housing, position side cover on housing, then install attaching studs, using new lock washers. Adjust lever shaft thrust as previously directed under "Lever Shaft Thrust Adjustment" in this section.

9. Fill gear housing with lubricant specified in Lubrication (Sec. 13 of this manual).

COLUMN ASSEMBLY (Fig. 3)

1. Place upper bevel gear shims (steel) on bevel gear housing studs and place lower bevel gear shims (brass) in bevel gear housing. NOTE: Shims are available in .003 and .010 inch thicknesses and an average of three (3) each are required.

2. Position lower bevel gear (11) in bevel gear housing (9), then install lower gear bearing (12).

3. Press bearing oil seal (13) into bearing cap (14), position new gasket on bevel gear housing studs, then install bearing cap (14). Install splined yoke (16).

4. If horn wire tube was removed, place tube in housing and install tube bushing.

5. Place steering shaft and upper bevel gear (8) in housing (9), then install upper gear bearing (7), adjusting nut lock (6) and bearing adjusting nut (5). Tighten nut until inner race of upper gear bearing rests solidly on shoulder of bevel gear, then lock nut in place.

6. Press upper bearing (3) into steering column assembly (4) until shoulder of bearing retainer rests on column jacket.

7. Position column assembly (4) on bevel gear housing studs, then install new lock washers and nuts, tightening nuts securely.

8. Adjust bevel gears as directed previously, under "Adjusting Bevel Gear Backlash," in this section.

Steering Gear Installation (Fig. 1)

1. Place steering gear housing into position, then attach to vehicle under structure with four mounting bolts.

2. Place steering propeller shaft assembly into position, then install U-bolts which attach U-joint journal to tapered yoke mounted on cam and shaft assembly.

3. Position steering column assembly on bevel gear housing bracket, then, working through fog lamp opening, install nut and new cotter pin on bevel gear housing stud.

4. Insert horn wire terminal into connector, then install fog lamp as directed in Lighting (Sec. 7G of this manual).

5. Position U-joint journal in splined yoke, mounted on shaft of lower bevel gear, and secure with U-bolts. Connect lubrication and overflow tubes (15, fig. 2) to fittings in bevel gear housing.

6. Place housing cap on steering column gear shift housing and install four cross recess screws, tightening screws securely.

7. After placing Woodruff key in slot in upper shaft, position steering wheel on shaft. Install steering wheel retaining nut and tighten securely.

8. Place lower contact spring over steering wheel retaining nut, then install base plate assembly in steering wheel. Install contact cap, contact spring, horn contact cup, and horn button in center of steering wheel.

9. Place vehicle wheels in straight-ahead position and turn steering wheel to center of steering gear travel. Install Pitman arm on end of lever shaft aligning mark on arm with mark on shaft. Install new lock washer then secure Pitman arm with nut. Checking front end alignment at this time is also recommended.

10. Assemble and connect drag link to Pitman arm as instructed later under "Steering Drag Link" in this section.

11. Reinstall steering gear removable cover seal, steering gear removable cover, and driver's seat.

STEERING DRAG LINK

Steering drag link assembly is three piece type, comprised of drag link and two end assemblies. As shown in figure 8, drag link ends are roller bearing type and incorporate an adjustment feature which automatically compensates for wear on bearing surfaces. Both end assemblies are

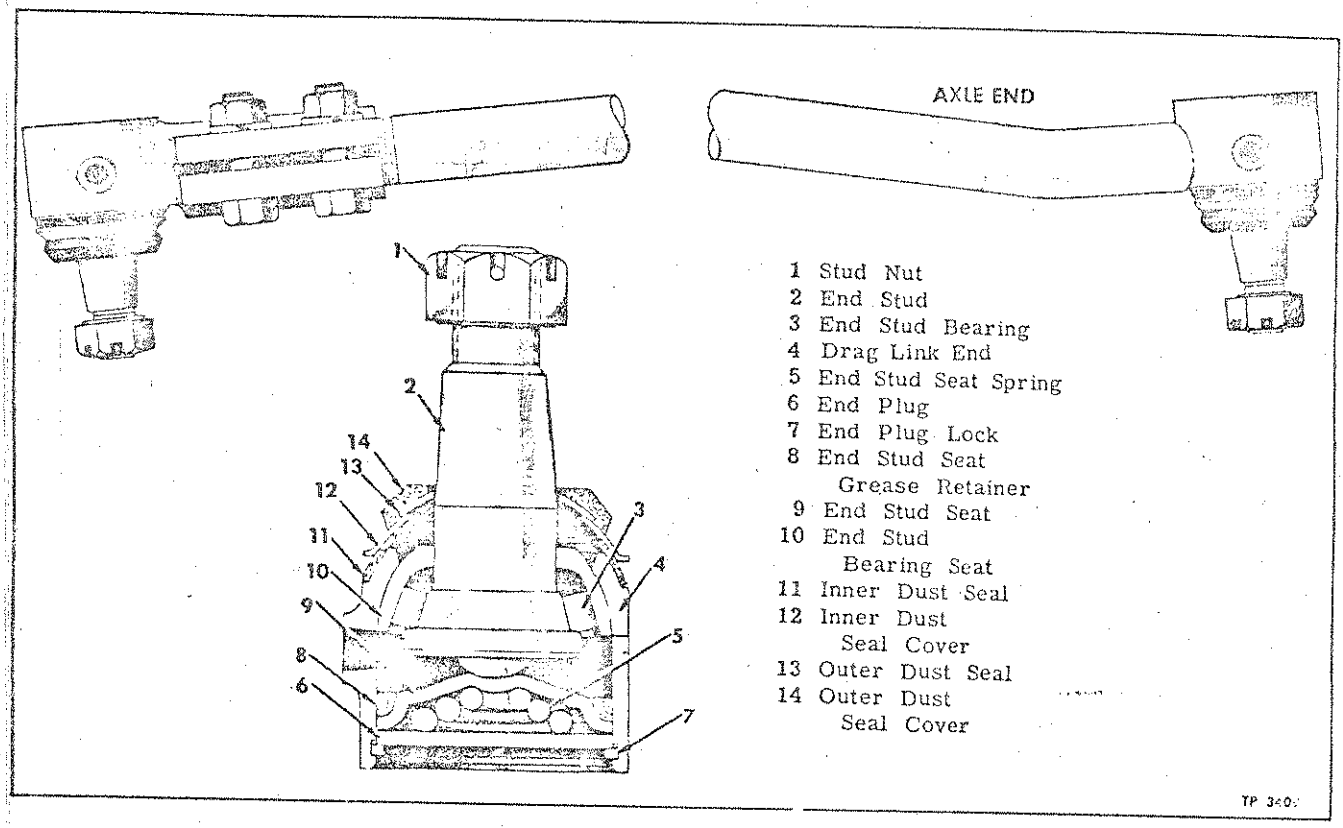


Figure 8—Steering Drag Link

identical, except, end assembly at Pitman arm screws onto drag link, to provide for length adjustment, while end at axle is integral with link. Drag link end, at Pitman arm, is retained on drag link with clamp bolts. Drag link installation is shown in figure 1.

MAINTENANCE

Linkage between steering gear and front axle definitely affects steering action if parts are out of adjustment, bent, or twisted. Check steering geometry and front wheel alignment when steering linkage is repaired or replaced.

Drag link end stud nuts must be kept tight or stud holes in steering arm and Pitman arm may become enlarged as a result of excessive looseness. Subsequent tightening of stud nuts may draw studs into arms so far, that dust cover parts may be damaged during sharp turns.

Drag link ends are equipped with lubrication fittings and should be lubricated as directed in Lubrication (Sec. 13 of this manual).

LENGTH ADJUSTMENT

It should not be necessary to alter length of drag link except when new link is installed. If necessary to adjust drag link length, proceed as follows:

1. Connect rear drag link end to axle steering arm. Be sure drag link end is thoroughly lubricated.

2. Locate center of steering movement by turning steering wheel from right extreme to left extreme, counting the number of turns. Then back up exactly half way. With front wheels in straight ahead position, front ball socket of drag link should fit on Pitman arm without changing position of Pitman arm or front wheels.

3. If parts do not assemble correctly, first check all linkage for bends or distortion. If none of the drag link parts are found to be bent or twisted, loosen clamp bolts, then turn front drag link end enough to obtain length to permit installation of end stud in Pitman arm without twist or bind.

4. Tighten clamp bolts firmly, then test adjustment. Front wheels should turn from right to left extremes without noticeable binding at drag link ends.

DRAG LINK END REPAIR

Normal wear on bearing surfaces in drag link end will result in increased overall height of assembly. If excessive play is noted, drag link ends must be removed and disassembled for replacement of worn parts.

STEERING GEAR

REMOVAL AND DISASSEMBLY (Fig. 8)

1. Disconnect drag link ends from steering arms and Pitman arm by removing cotter pins and nuts from end studs and driving studs out of arms.

2. Loosen clamp bolt nuts and unscrew drag link end from drag link.

3. Remove outer dust seal cover (14), outer dust seal (13), inner dust seal cover (12), and inner dust seal (11) from end stud (2).

4. Pry end plug lock (7) out of drag link end (4), then remove end plug (6), end stud seat spring (5), end stud seat (9), grease retainer (8), end stud (2), end stud bearing (3), and end stud bearing seat (10) from drag link end.

CLEANING AND INSPECTION

1. Immerse all parts, except dust seal covers (12 and 14) in suitable cleaning fluid, use a stiff bristle brush as required, and clean parts thoroughly.

2. Check all parts for wear or corrosion and discard parts that are badly damaged.

3. Check tension of end stud seat spring (5). Discard spring if tension is not within limits given in "Specifications" at end of this section.

4. Carefully inspect rollers in end stud bearing assembly (3) for roughness or flaking. If rollers will not rotate freely in retainer, bearing assembly should be replaced.

ASSEMBLY AND INSTALLATION

Keep all parts clean when performing assembly operations. If dirt or grit is allowed to get into drag link end when assembling, premature and excessive parts wear will result.

1. Lubricate all parts with lubricant specified in "Lubrication" (Sec. 13 of this manual), then place end stud bearing (3) and end stud bearing seat (10) on end stud (2).

2. Insert stud and bearing assembly into drag link end (4), then press grease retainer (8) over end of end stud seat (9). Place stud seat in drag link end, then install end stud seat spring (5), and end plug (6). Secure parts in drag link end (4) with end plug lock (7).

3. Install on threaded end of stud, in following order, inner dust seal (11), inner dust seal cover (12), outer dust seal (13), and outer dust seal cover.

4. Install drag link end assembly on drag link, but do not tighten clamp bolt nuts.

5. Place drag link in position on vehicle, then connect end stud to steering arm at axle.

6. Adjust length, as previously directed under "Length Adjustment." in this section, then lubricate as directed in Lubrication (Sec. 13 of this manual).

SPECIAL TOOLS

Reference is made to special tools in this section. These tools, or their equivalent, are necessary and are recommended to more readily and efficiently accomplish certain service operations. The tools, however, are not supplied by GMC Truck & Coach Division. Names and addresses of vendors or manufacturers are shown as a reference, and since such vendors are the suppliers of these tools, information regarding availability, price, etc., should be obtained directly from them.

No.	Name	Code
J-452G	Steering Wheel Puller	KM
J-489	Jacket Bearing Remover	KM

Code	Vendor	Address
KM	Kent Moore Organization	Detroit, Mich.

SPECIFICATIONS

STEERING GEAR

Make	Ross Gear & Tool Co.
Type	Cam & Roller - Twin Lever
Gear Ratio	23 to 1
Steering Wheel Diameter	22 in.

CLEARANCE

Housing diameter at lever shaft bushing	1.873 - 1.875 in.
Lever Shaft bushing length	
Inner Bushing	1.250 - 1.253 in.
Outer Bushing	1.48 - 1.50 in.
Lever shaft bushing O.D.	1.876 - 1.877 in.
Lever shaft bushing I.D.	1.7485 - 1.7500 in.
Lever shaft diameter	1.7465 - 1.7475 in.
Clearance - bushing to shaft	0.001 - 0.0035 in.
Clearance - bushing to housing	(0.001 - 0.004 in.) Tight
Lever shaft stud bearing	
Outer race - O.D.	1.938 - 1.939 in.
Lever shaft stud hole diameter	1.936 - 1.937 in.
Clearance - race to shaft	(0.001 - 0.003 in.) Tight
Housing diameter at cam bearing seats	2.750 - 2.752 in.
Cam bearing outer race diameter	2.748 - 2.749 in.
Clearance - Race to housing	0.001 - 0.004 in.

ADJUSTMENTS

Cam Bearings

Adjustment type	Shims
Shim sizes available	0.002, 0.003, & 0.010 in.
Adjust to	Slight Drag (see text)

Lever Shaft Thrust

Adjustment type	Adjuster Screw
Adjust to	Slight Drag (see text)

Lever Shaft Stud Bearings

Adjustment type	Adjuster Nut
Adjust to	See Text

Bevel Gears

Adjustment type	Shims
Shim sizes available	0.003 in. & 0.010 in.
Adjust to	No Perceptible Backlash

STEERING DRAG LINK

Type	Adjustable Length
Stud centers	37-7/16 in.

Stud Seat Spring

Free length	3/4 in.
Lbs. pressure at 1/2 in.	350 - 400 lbs.
Solid Height	27/64 in.

STEERING GEAR

SERVICE BULLETINS

Service Bulletins are issued, whenever required, supplementing information in this section. The information contained in these bulletins should be noted in the text and bulletin filed for future reference - Make note of bulletin number in space below:

NOTES

Transmission

Contents of This Section

Related Subjects in Other Sections

Mechanical transmission (fig. 1), has four forward speeds and one reverse. All mainshaft, reverse idler, and countershaft gears have helical cut teeth and are in constant mesh. Interlocking (sliding) clutches with spur teeth on inner diameter slide on corresponding teeth on clutch gears.

Power is transmitted from transmission to propeller shaft through a spiral bevel gear angle drive unit which forms part of transmission assembly.

Transmission, clutch and engine are mounted as a unit, the weight at rear of which is carried at transmission case. Access to transmission is gained through engine compartment doors.

The terms "Front" and "Rear" as used in following description and illustrations do not apply to the mounted position of transmission in coach. Following the common usage of those terms - "Front" applies to clutch end of transmission, while "Rear" applies to propeller shaft end. Key numbers in text refer to figures 1 and 2.

MAINSHAFT AND GEARS

Mainshaft (71) is supported at rear end by opposed tapered roller bearings (68 and 69) mounted in angle drive case end cover (59). Mainshaft center roller bearing (42) mounted in main case (9) directly in front of bevel pinion (64), supports mainshaft at that point. Front of mainshaft is supported by main drive gear pilot roller bearing (11) mounted in pocket of main drive gear (2). Main drive gear (2) is supported in main case (9) by single row ball bearing (5).

Mainshaft 3rd and 4th speed clutch gear (14) is mounted on splined portion of mainshaft and held in place with mainshaft gears retaining nut (12) and lock washer (13). First and 2nd speed clutch gear is integral with mainshaft.

Mainshaft 1st (39), 2nd (30), and 3rd (22) speed constant mesh gears are each mounted on double row needle bearings. Rows of bearings are separated by spacers.

COUNTERSHAFT AND GEARS

Countershaft (87) is supported at rear by single row ball bearing (85) held on shaft with two lock nuts (84 and 82) and lock washer (83). Front end of shaft is supported on counter shaft front roller bearing (104) which is prevented from coming out of case by clutch housing (10). Inner race of roller bearing (104) is held on shaft by countershaft front bearing nut (106) and retaining washer (105).

Countershaft drive gear (101) and countershaft 3rd speed gear (97) are keyed to shaft and separated by spacer (99). Countershaft 2nd speed gear (95) and countershaft clutch gear (94) are integral with shaft.

Countershaft 1st speed gear (89) is not keyed to shaft, but is carried on bronze bushing (90) and is driven by countershaft sliding clutch (91) carried on countershaft clutch gear (94). Countershaft sliding clutch (91) is operated by reverse shift fork and is engaged in all forward speeds.

TRANSMISSION

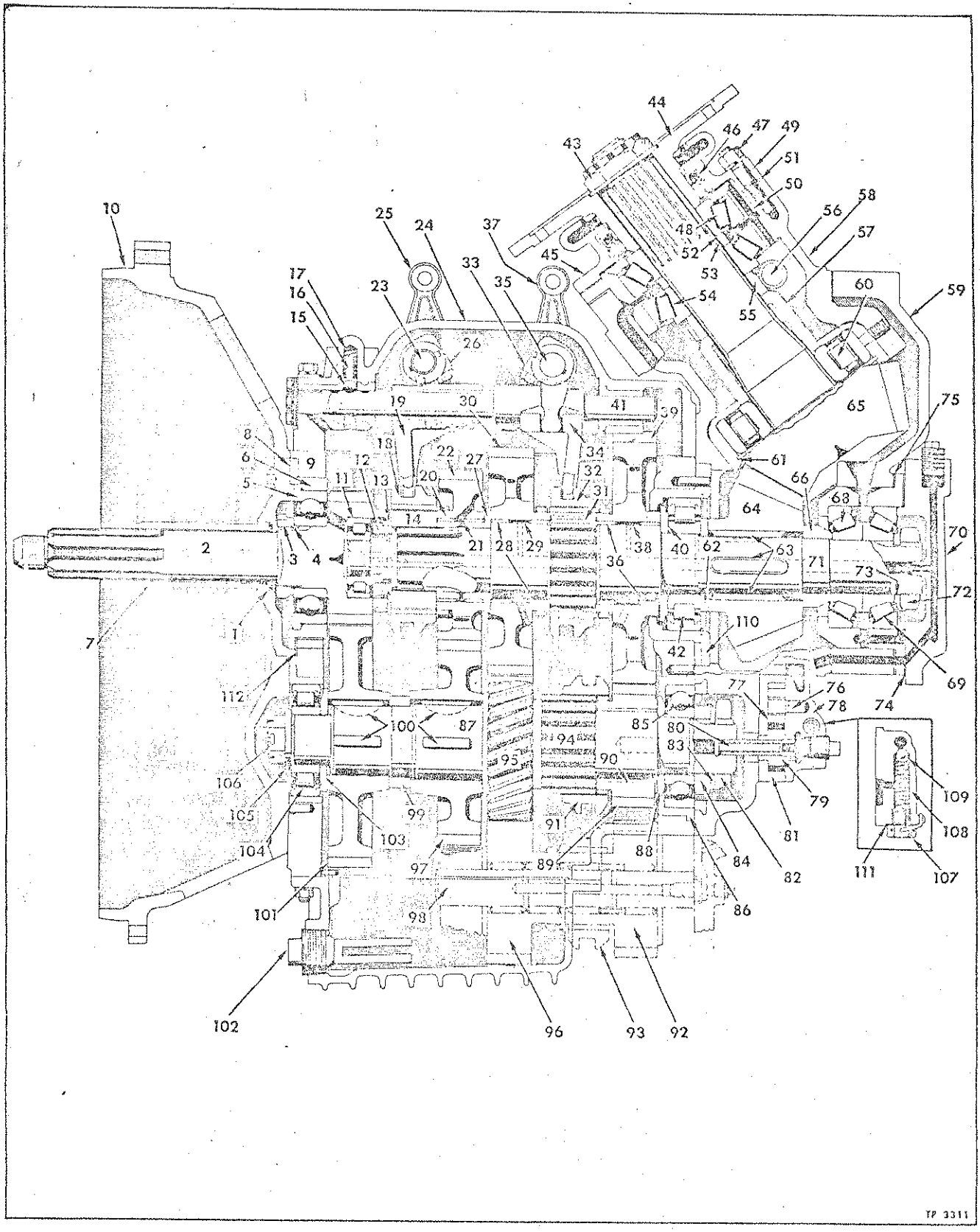


Figure 1—Sectional View of Transmission

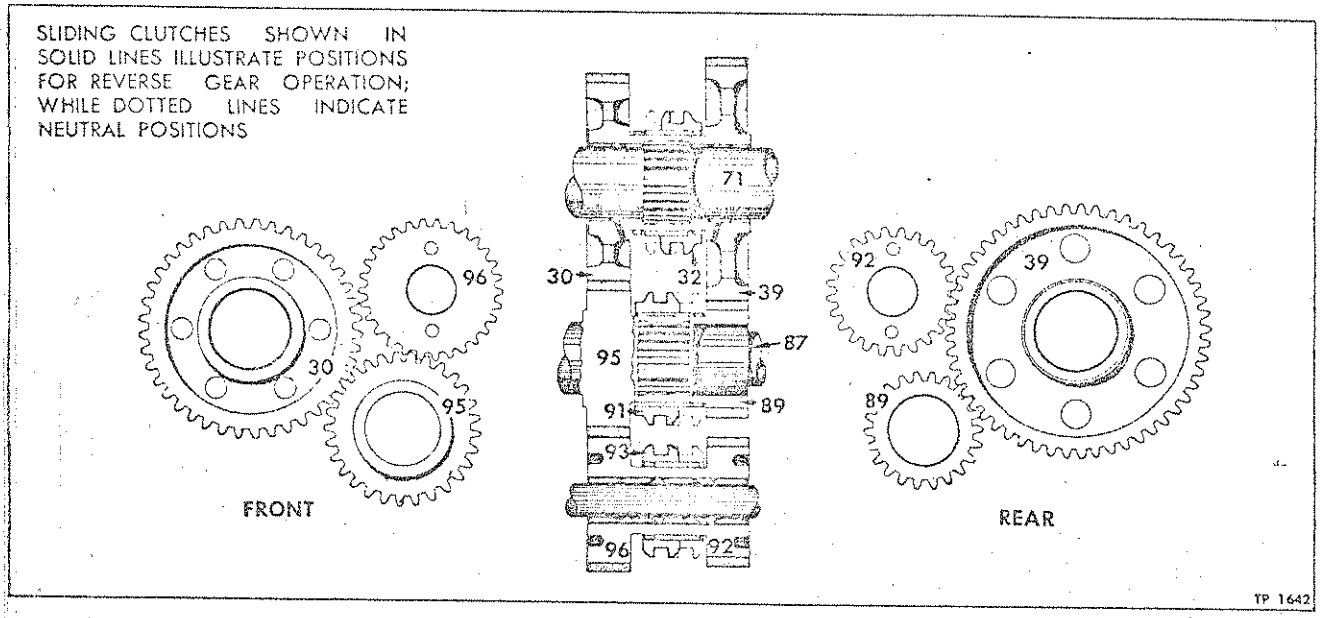


Figure 2—Arrangement of Mainshaft, Countershaft and Reverse Idler Gears and Sliding Clutches for Reverse Operation

1 Oil Seal
2 Main Drive Gear
3 Bearing Lock Nut
4 Lock Washer
5 Main Drive Gear Bearing
6 Bearing Retainer
7 Main Drive Gear Bearing Cap
8 Shims
9 Transmission Main Case
10 Clutch Housing
11 Mainshaft Pilot Bearing
12 Mainshaft Nut
13 Nut Lock Washer
14 3rd and 4th Speed Clutch Gear
15 Poppet Ball
16 Plunger
17 Spring
18 3rd and 4th Speed Sliding Clutch
19 3rd and 4th Speed Shift Fork
20 3rd Speed Gear Bearings
21 Spacer
22 3rd Speed Gear
23 3rd and 4th Speed Shift Shaft
24 Main Case Cover
25 3rd and 4th Speed Shift Lever
26 3rd and 4th Speed Shift Finger
27 3rd and 4th Speed Gear Thrust Collar
28 2nd Speed Gear Bearings
29 Bearing Spacer
30 Mainshaft 2nd Speed Gear
31 1st and 2nd Speed Clutch Gear
32 1st and 2nd Speed Sliding Clutch
33 1st, 2nd, and Reverse Shift Finger
34 1st and 2nd Speed Shift Fork
35 1st, 2nd, and Reverse Shift Shaft
36 1st Speed Gear Bearings
37 1st, 2nd, and Reverse Shift Lever
38 Bearing Spacer
39 Mainshaft 1st Speed Gear
40 1st Speed Gear Thrust Washer
41 1st, 2nd, and Reverse Shift Rod
42 Mainshaft Center Bearing
43 Propeller Shaft Flange Nut
44 Propeller Shaft Flange
45 Bearing Cap
46 Oil Seal
47 Bearing Cap Stud Nut
48 Angle Drive Outer Tapered Bearing
49 Gasket
50 Bearing Retainer
51 Shims
52 Shims
53 Bearing Spacer
54 Angle Drive Inner Tapered Bearing
55 Speedometer Drive Gear
56 Speedometer Driven Gear
57 Spacer
58 Angle Drive Case
59 Angle Drive Case Cover
60 Angle Drive Gear Roller Bearing
61 Snap Ring
62 Bevel Pinion Front Spacer
63 Bevel Pinion Key
64 Bevel Pinion
65 Angle Drive Gear and Shaft
66 Bevel Pinion Rear Spacer
67 Bearing Retainer
68 Mainshaft Inner Rear Bearing
69 Mainshaft Outer Rear Bearing
70 Mainshaft Rear Bearing Cap
71 Mainshaft
72 Mainshaft Rear Bearing Nut
73 Lock Washer
74 Shims
75 Shims
76 Oil Pump Driven Gear Shaft
77 Oil Pump Driven Gear
78 Oil Pump Cover
79 Oil Pump Drive Gear
80 Oil Pump Drive Shaft
81 Oil Pump Housing
82 Outer Nut
83 Lock Washer
84 Inner Lock Nut
85 Countershaft Rear Bearing
86 Countershaft Rear Bearing Retainer
87 Countershaft
88 Countershaft 1st Speed Gear Thrust Washer
89 Countershaft 1st Speed Gear
90 Countershaft 1st Speed Gear Bushing
91 Countershaft Sliding Clutch
92 Reverse Idler Drive Gear
93 Reverse Idler Sliding Clutch
94 Countershaft Clutch Gear
95 Countershaft 2nd Speed Gear
96 Reverse Idler Driven Gear
97 3rd Speed Countershaft Gear
98 Reverse Idler Shaft
99 Spacer
100 Countershaft Gear Key
101 Countershaft Drive Gear
102 Magnetic Drain Plug
103 Drive Gear Retaining Washer
104 Countershaft Front Bearing
105 Bearing Retaining Washer
106 Countershaft Bearing Retaining Nut
107 Relief Valve Plug
108 Relief Valve Spring
109 Oil Pump Relief Valve Ball
110 Mainshaft Center Bearing Retainer
111 Pressure Relief Valve Plug Washer
112 Bearing Retainer Gasket

TP 3311 B

Legend for figures 1 and 2

TRANSMISSION

REVERSE IDLER GEARS

Reverse idler driving and driven gears (92 and 96) are mounted on roller bearings, with two bearings in each gear separated by spacers.

Reverse idler gears are separate, revolving independently of each other in all forward speeds. Reverse idler driven gear (96) is in constant mesh with countershaft 2nd speed gear (95) and reverse idler driving gear (92) is in constant mesh with mainshaft 1st speed gear (39). Reverse idler sliding clutch (93) is carried on hub of reverse idler driving gear, and engages both gears during reverse speed.

OIL PUMP

Transmission lubricant is circulated to various points throughout transmission by means of a conventional gear type oil pump mounted on rear side of angle drive case. Oil pump drive is accomplished by fitting end of oil pump shaft (80) into rear end of countershaft (87).

Oil pump drive gear (79) hubs project on both sides and fit into oil pump housing (81). Oil pump driven gear is bushed and turns on shaft (76) pressed into oil pump cover (78). Pump is fitted with spring loaded pressure relief valve, consisting of a ball (109) and spring (108) held in place by screw type plug (107).

OIL SEALS

Spring loaded synthetic rubber type oil seals are used at main drive gear bearing cap (1) and at output shaft bearing cap (46). Spring loaded leather oil seals are used at three points on shift shafts in transmission cover. See figure 4, items 11, 16, and 26.

Before leather seals are installed, they should be soaked in "Neatsfoot" oil or warm engine oil until leather portion of seal is soft and pliable. This procedure will insure an efficient leak-proof seal and also assists in installation. Seal assemblies should be replaced in overhaul periods.

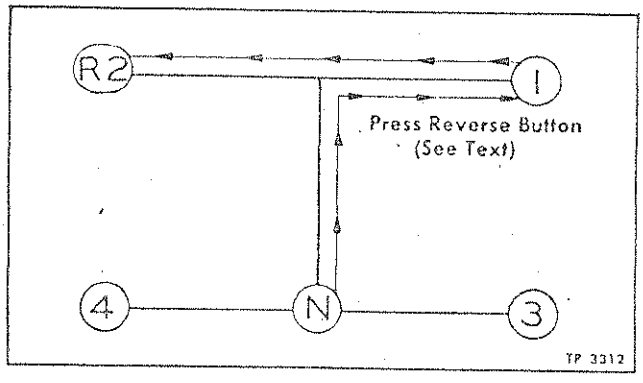


Figure 3—Gear Shifting Diagram

SHIFTING MECHANISM

Gearshift lever is located just below steering wheel at right-hand side of steering column. Mechanical linkage consisting of levers, shaft rods and bell cranks (fig. 5) transmit movement of gearshift lever to mechanism at transmission control cover.

The forward controls at steering column (fig. 10) are enclosed in housing which also encloses steering column above instrument panel.

Reverse Solenoid and Relay (Figs. 7 and 8)

The reverse solenoid, mounted on the transmission assembly is used to furnish pulling force to move shift finger into engagement with reverse speed shift fork.

Reverse solenoid has two coils, one known as a pulling coil and the other referred to as holding coil. Electrical circuit to solenoid is completed by means of solenoid relay mounted on engine compartment panel. Relay is in turn controlled by reverse switch button at panel to the left of driver. Relay control circuit is protected by No. 1 fuse at instrument panel.

When gearshift lever is in 1st speed position the shift finger (19, fig. 4) is in line with notch in reverse speed shift fork, hence pressing the reverse button at this time causes reverse solenoid to operate, thereby moving finger into engagement with the reverse shift fork.

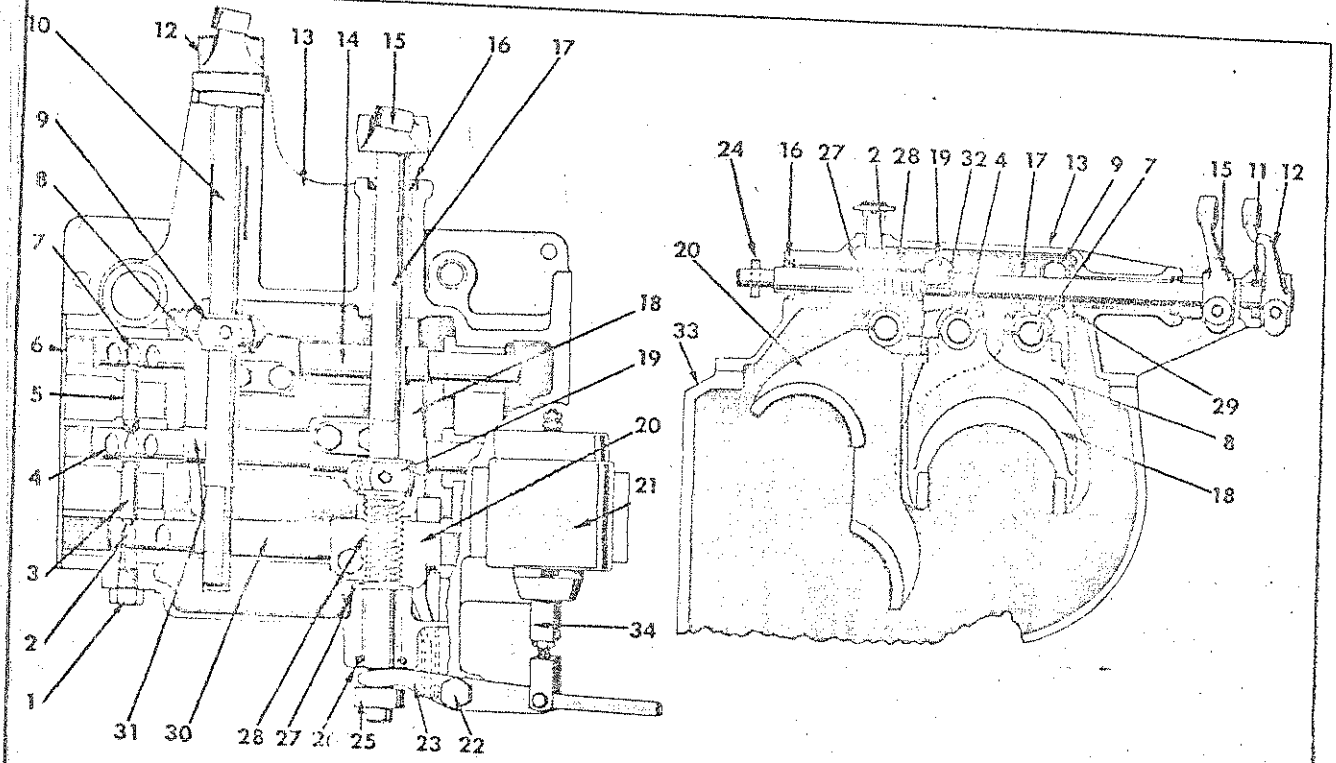
As gearshift lever is moved through reverse shift path (fig. 3), the reverse idler drive and driven gears are locked together by clutch and at same time countershaft 1st speed gear is disengaged from countershaft to become an idler gear for reverse operation.

Both coils in reverse solenoid (fig. 8) are energized to move the shift finger in transmission, but as solenoid plunger reaches end of its travel it strikes a pin which opens a set of points thereby breaking circuit through pulling coil The holding coil remains energized however and will hold the solenoid plunger "in" as long as driver presses the reverse switch button. Refer to Wiring (Sec. 7A of this manual) for wiring, circuits, etc.

OPERATION

Forward speeds are shifted manually by means of shift lever interconnected to transmission shift tower by control rods and levers (fig. 5).

This section describes the path by which power flows through the transmission assembly as vehicle is operated. Shifting diagram shown in figure 3 may be referred to for gearshift lever position for each transmission speed.



1 Interlock Pin Plug
2 Reverse Speed Rod
3 Interlock Pin
4 1st and 2nd Speed Rod
5 Interlock Pin
6 Shift Rod End Plate
7 3rd and 4th Speed Shift Rod
8 3rd and 4th Speed Shift Fork
9 3rd and 4th Speed Shift Finger
10 3rd and 4th Speed Shift Shaft
11 Oil Seal
12 3rd and 4th Speed Shift Lever
13 Cover
14 Stop Sleeve
15 1st, 2nd, and Reverse Speed Shift Lever
16 Oil Seal
17 1st, 2nd and Reverse Speed Shift Shaft
18 1st, and 2nd Speed Shift Fork
19 1st, 2nd, and Reverse Speed Shift Finger
20 Reverse Speed Shift Fork
21 Reverse Solenoid
22 Solenoid Shift Lever Screw
23 Reverse Solenoid Shift Lever
24 Collar Pin
25 Solenoid Fork Collar
26 Oil Seal
27 Washer
28 Reverse Lockout Spring
29 Washer
30 Stop Sleeve
31 Stop Sleeve
32 Shift Finger Key
33 Transmission Main Case
34 Solenoid Linkage

TP 3315

Figure 4—Sectional View of Transmission Cover

Refer to Operation (Sec. O in this manual) for driver's instructions.

FIRST SPEED

The 1st and 2nd speed sliding clutch (32) is engaged with mating teeth on mainshaft 1st speed gear (39) and the power flow is from main drive gear (2) to countershaft drive gear (101), through countershaft (87) to countershaft 1st speed gear (89), to mainshaft 1st speed gear (39), through sliding clutch (32) and clutch gear (31) to mainshaft (17), through mainshaft to angle drive gears and output shaft (65).

SECOND SPEED

First and 2nd speed sliding clutch (18) is engaged with mating teeth on mainshaft gear (30). Power flow is main drive gear (2) to countershaft drive gear (101), to 2nd speed gear (95), to mainshaft 2nd speed gear (30), to clutch (32) and clutch gear (31), to mainshaft (71), through mainshaft to angle drive gears.

THIRD SPEED

The 3rd and 4th speed sliding clutch (18) is engaged with mating teeth on mainshaft 3rd speed gear (22) and power flow is from main drive gear (2) to countershaft drive gear (101), through

TRANSMISSION

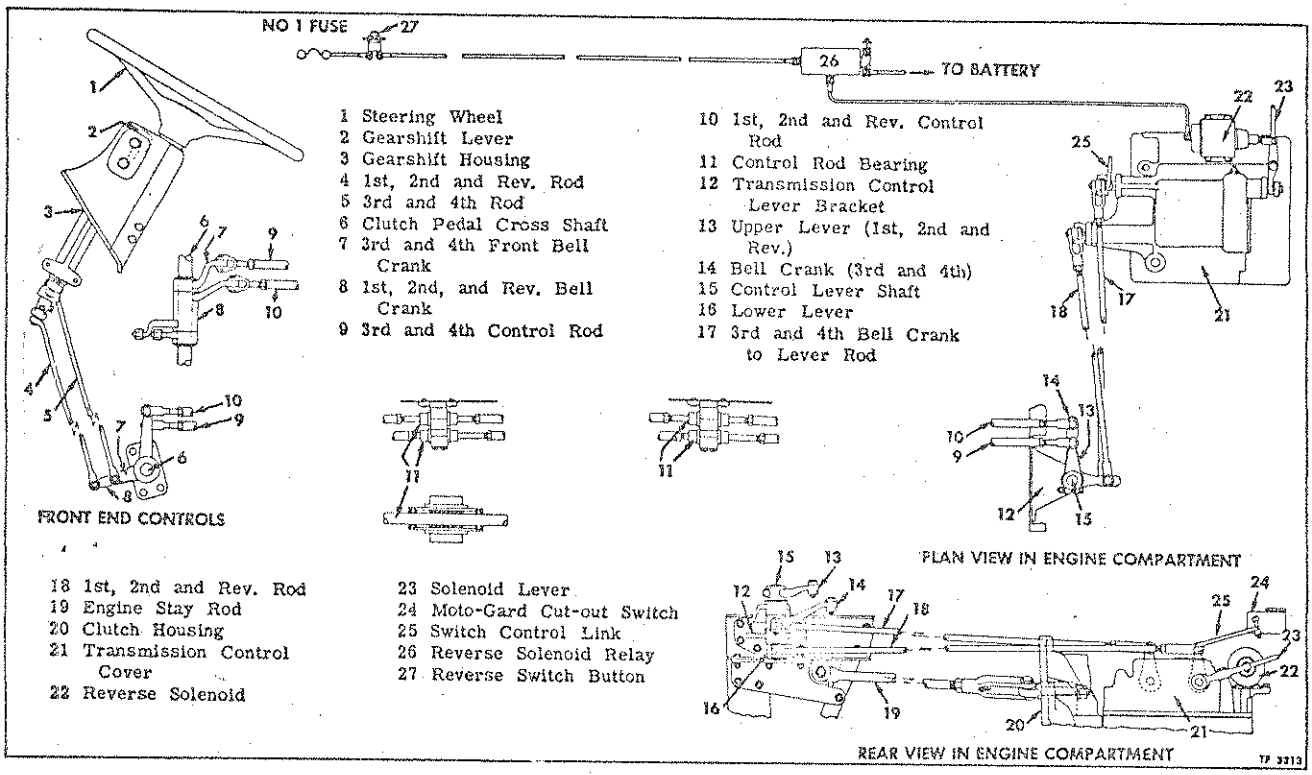


Figure 5—Transmission Controls and Linkage

countershaft (87) to countershaft 3rd speed gear (22) and through sliding clutch (18) and clutch gear (14) to mainshaft, through mainshaft to angle drive gears and output shaft (65).

FOURTH SPEED

The 3rd and 4th speed sliding clutch (18) is engaged with mating teeth at rear of main drive gear (2), and power flow is directly through sliding clutch (18) and clutch gear (14) to mainshaft and to angle drive gears and output shaft (65).

REVERSE SPEED

Reverse speed is shifted manually using same controls as forward speeds, but is assisted by a solenoid mounted on transmission shift cover and controlled by a button mounted on coach body at left of driver (fig. 5).

To shift from neutral into reverse speed, move gear shift lever into first speed position engaging first speed gears. Refer to figure 1. Energize solenoid on transmission by pressing reverse button. Solenoid moves shift finger in transmission cover from first and second speed fork to reverse speed fork. Move gear shift lever into second position which moves reverse shift fork forward disengaging sliding clutch on countershaft and engaging sliding clutch on reverse idler gears. Control button must be held in depressed position until shift into reverse is complete.

For reverse operation, sliding clutches are positioned and gears are meshed as shown in figure 2, and power flow is from main drive gear (2) to countershaft drive gear (101), through countershaft to 2nd speed gear (95), to reverse idler driven gear (96) and driving gear (92), to mainshaft 1st speed gear (39), through sliding clutch (32) to mainshaft, to angle drive gears and output shaft.

MAINTENANCE ON VEHICLE

The light maintenance operations covered in this paragraph include items which should be periodically inspected and those minor repairs and adjustments which may be accomplished without removing transmission from vehicle.

TRANSMISSION CONTROL ROD ADJUSTMENT

Provisions are made for adjustment of control rod length by use of adjustable yokes. When replacing transmission or any of the control linkage, be sure linkage is adjusted as follows, before attempting to operate vehicle:

1. Place gearshift lever in neutral position; then move transmission gears into neutral position by operating levers (25 and 37, fig. 1).

2. Adjust yokes on rods (17 and 18, fig. 5) so that clevis pins can be inserted without moving rods or levers from neutral position. Make certain

ock nuts are tightened after adjustment has been made.

INSPECTION AND LUBRICATION

At regular intervals inspect for looseness of transmission mounting bolts, also transmission cover retaining bolts. Inspect for evidence of lubricant leakage at bearing caps and at filler and drain plugs.

Refer to Lubrication (Sec. 13 of this manual) for recommendations on type and quantity of lubricant to use and also for recommended lubrication intervals.

A sump in lower position of main case is equipped with magnetic type drain plug. This plug should be removed and cleaned at draining periods. Angle drive case is also equipped with magnetic type plug which should be cleaned at regular periods. "Hot" and "Cold" levels shown on dip stick (fig. 6) refer to lubricant level when lubricant is hot or cold, respectively.

REVERSE SOLENOID RELAY ADJUSTMENT (Fig. 7)

If difficulty is experienced when shifting transmission into reverse, the trouble may lie in the relay or wiring. Engine control switch must be "on" to supply current to relay circuit. Check No. 1 fuse at instrument panel. If fuse is not burned out, trace circuit to engine compartment panel. Refer to Wiring (Sec. 7A of this manual) for wiring diagram.

When certain that current will flow to relay, check and adjust as follows:

1. Be sure wiring connections are clean and tight at each relay terminal.

2. Remove relay cover and examine points. If points are burned or pitted, disconnect wire from terminal marked "B" and dress points using a thin fine cut point file.

3. Measure point opening. Correct setting is .035 inch. If necessary to change point opening, bend stop as indicated in figure 7.

4. Measure air gap between armature and relay coil core. Air gap should be .012 inch with points closed. If necessary to change air gap, loosen air gap adjustment screws (fig. 7) and move armature up or down as required. If necessary, align support carrying lower contact so that air gap will be uniform between core and armature.

5. Install relay cover and attach any wires removed during adjustment.

REVERSE SOLENOID LINKAGE ADJUSTMENT

Whenever the reverse solenoid has been removed, or if difficulty is experienced when shifting transmission into reverse speed; the following procedure will properly adjust the solenoid linkage.

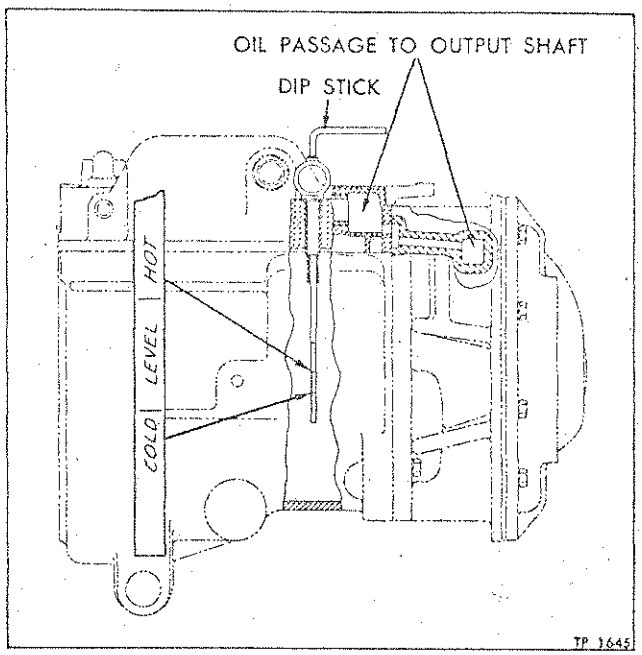


Figure 6—Check Lubricant on Dip Stick

1. Make certain transmission control rod linkage is correctly adjusted.

2. Place gear shift lever in first speed position.

3. Remove cover from rear of reverse solenoid, and inspect contact points. If points are burned or pitted, dress with a fine cut point file.

4. Manually shift reverse solenoid lever into reverse speed position.

5. Adjust lock nuts on solenoid link screw so that solenoid points just break, with the 1st, 2nd and reverse speed shift shaft moved fully into reverse speed position (fig. 8).

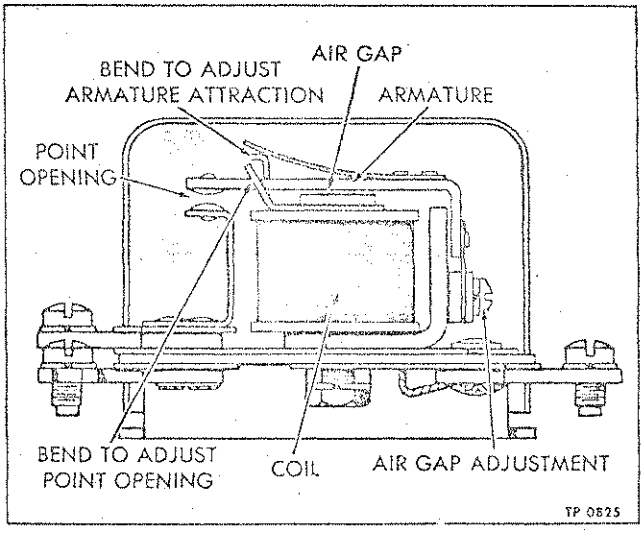


Figure 7—Reverse Solenoid Relay

TRANSMISSION

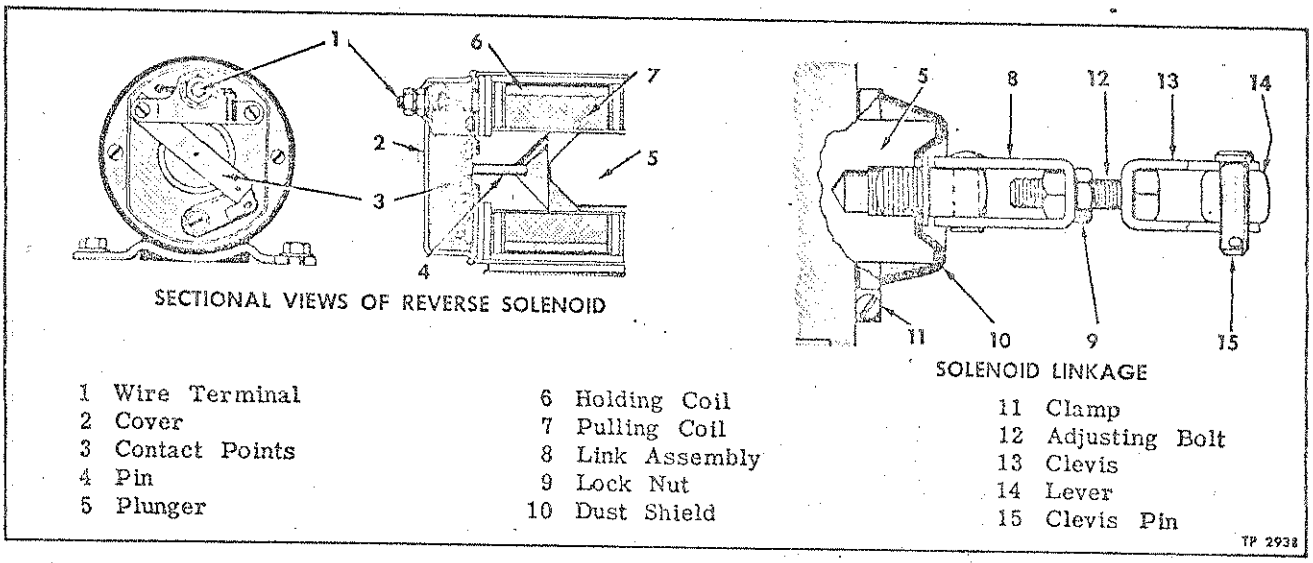


Figure 8—Reverse Solenoid and Linkage

TRANSMISSION REPLACEMENT

TRANSMISSION REMOVAL

Transmission may be removed from vehicle as a unit without removing complete power plant as follows:

1. Remove dust pans from beneath engine and transmission, then place engine dolly under engine flywheel housing to relieve weight at power plant rear mountings

2. Disconnect clutch, hand brake, and transmission control rods from levers at transmission by removing clevis pins which attach rod yokes to levers.

3. Disconnect electrical wiring from reverse solenoid and speedometer sending unit. Also detach engine ground strap.

4. Break seal wire (fig. 9) and remove plate inclosing duo-speed governor cable connection at transmission cover. Back off guide (8), loosen eye-bolt nut which clamps cable to lever, then unscrew tube nut (9) to detach governor cable tube from transmission cover. Lift tube and cable assembly away from transmission.

5. Remove two bracket to insulator bolts at left-hand side of transmission case, and one bolt through insulator and channel, at right-hand side of transmission at bulkhead.

6. Remove bumper support to engine support channel brace, remove bolts attaching lower insulator to support channel, then remove strut to channel bolt at right-hand rear side of transmission. Remove bolt at top of strut and remove strut.

7. Disconnect engine stay bar by removing clevis pin at clutch housing eye bolt.

8. Place transmission dolly under transmission to take weight of the assembly, then remove bolts and cap screws attaching clutch housing to engine flywheel housing.

9. Loosen slip joint dust cap on propeller shaft so joint can be pulled apart as transmission is removed.

10. Move transmission assembly straight away from engine assembly, being careful to keep transmission drive gear aligned with clutch disc hub as transmission is withdrawn. Jack screws in threaded holes in clutch housing flange may be used to force the clutch housing away from engine flywheel housing.

CLEANING

After transmission is removed from vehicle, reverse solenoid and linkage should be removed. Exterior of transmission should be thoroughly cleaned with a suitable solvent to loosen and remove all accumulated road dirt and grime. After all dirt and other foreign material has been removed, rinse with gasoline and blow dry with compressed air. NOTE: The use of caustic cleaning compounds should be avoided due to their deleterious effect on aluminum.

TRANSMISSION INSTALLATION

Coat clutch shaft splines sparingly with lubricant as directed in Lubrication (Sec. 13 of this manual). Install clutch release parts in clutch housing if they have been removed. Refer to Clutch (Sec. 5 of this manual) for clutch release mechanism information.

1. If hand brake mechanism and propeller shaft universal joint have been removed from transmission, refer to respective sections (4D or 18, of this manual) for construction of these as-

semblies, and assemble on transmission.

2. Support transmission on dolly with drive gear perfectly aligned with clutch disc hub, then move transmission toward engine meanwhile guiding propeller shaft slip joint splines together.

3. Bolt clutch housing firmly against flywheel housing and remove transmission dolly.

4. Install support strut at right-hand rear corner of coach, and install support channel and insulator under transmission. Install bolt through insulator and channel at bulkhead and the two insulator bolts at rear left-hand side of transmission case. Install bumper support brace.

5. Connect engine stay bar (19, fig. 5) at clutch housing, then remove engine dolly. Connect clutch, hand brake, and transmission control rods to levers at transmission. Moto-Gard cut-out switch (24, fig. 5) must be connected to special clevis pin which holds 1st, 2nd, and reverse rod to lever on transmission.

6. Connect engine ground strap, electric speedometer wiring and reverse solenoid wire to respective units.

7. Adjust all control rods as directed in "Transmission Control Rod Adjustment" previously this section. Also be sure to adjust clutch al free-travel to specified dimensions.

8. Remove plate enclosing duo-speed governor lever at transmission cover. Move governor control tube and cable into position with cable inserted through eye-bolt (7) in lever (fig. 9). Tighten tube nut into threads in transmission cover. Hold cable in exactly the same relationship to lever as it occupied before removal. If new cable is being installed, refer to "Duo-Speed Governor Adjustment" in Engine (Sec. 8B in this manual) for instructions on method of connecting cable to lever at transmission.

Be sure to tighten eye-bolt nut firmly and turn guide (8, fig. 9) in until inner end contacts cable, then tighten lock nut. After checking adjustment, the wire and seals must be installed as shown in figure 9.

9. Check lubricant level on dip stick (fig. 6) and if necessary add lubricant to "cold" level, referring to Lubrication (Sec. 13 of this manual) for lubricant specifications.

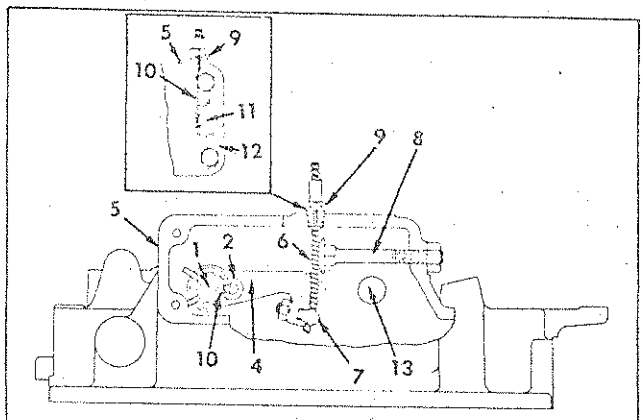
TRANSMISSION FORWARD CONTROLS

CONTROL REMOVAL AND DISASSEMBLY (Fig. 10)

Gearshift lever and control mechanism at er's position may be removed from vehicle d disassembled as follows:

1. Remove steering wheel.

2. Remove cover (cap) from rearward side of gearshift housing (20); also, remove instrument



1 3rd and 4th Shift Shaft
2 Lock
3 Woodruff Key
4 Governor Control Lever
5 Transmission Cover
6 Control Cable
7 Eye Bolt
8 Guide
9 Control Tube Nut
10 Lock Wire
11 Seal
12 Cover
13 1st, 2nd, and Reverse Shaft

TP 3320

Figure 9—Duo-Speed Governor Control

panel mounting screws and move panels sufficiently to gain access to lower end of shift control assembly. Remove directional signal switch plate from side of housing (20) and disconnect wiring.

3. Remove nuts attaching rods (26 and 28) to levers (24 and 27), Remove bolts attaching housing (20) at instrument panel, and two bolts holding lower end of housing to body structure.

4. Lift housing and control assembly upward and remove from vehicle.

5. Remove clamp bolt from lever (27) and remove lever and key.

6. Remove clamp bolt from lever (24), then drive lever and bearing assembly off tube and shaft. Remove key from tube (29) and remove items 17, 18 and 19 from tube at lower end of housing.

7. Remove housing cap (3), poppet retainers (5) and poppets (6) from housing.

8. Loosen bolt in shaft upper lever (12). Remove snap ring (10), then drive shaft (2) downward to remove shaft. Keyway in shaft permits shaft to be driven downward past key in upper lever (12).

9. Remove gearshift lever (15) with collar (13) and bearing as an assembly, then remove upper lever (12).

10. Remove clamp bolt from lever (16), then drive tube upward to expose lever key. Remove key, then drive tube out through bottom of housing and remove lever (16) and items 17, 18, and 19 from housing.

11. If necessary to replace the needle bearing assemblies (7, 9, or 21) these assemblies

TRANSMISSION

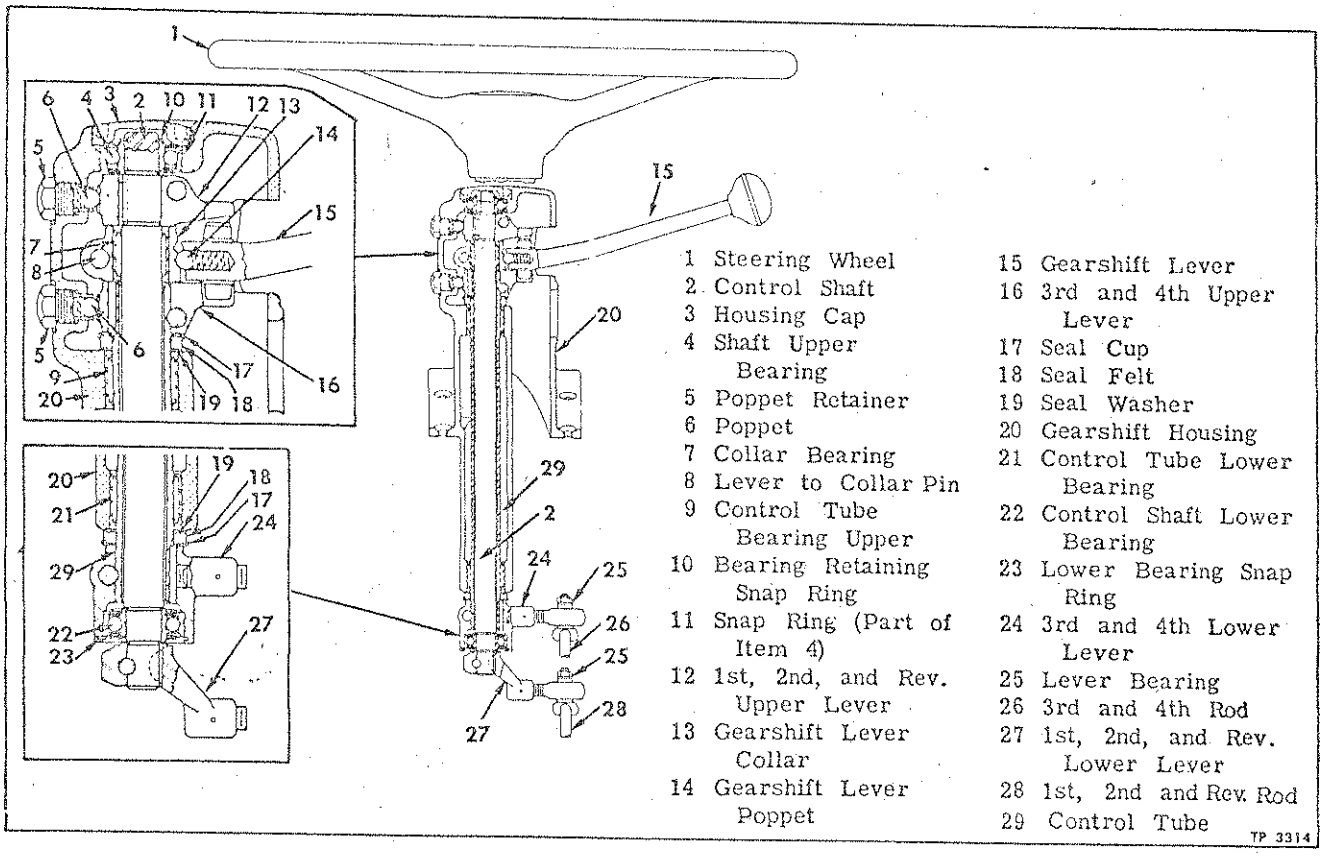


Figure 10—Sectional View of Transmission Controls at Steering Column

may be removed and new parts installed by using suitable driver to force out old bearings and install new ones.

12. To separate gearshift lever from collar (13), remove pin (8), Poppet (14) can then be removed for inspection. Bearing (22) may be removed from lever (24) after removing snap ring (23), and bearing (4) may be removed by pulling out through top of housing.

CONTROL ASSEMBLY AND INSTALLATION (Fig. 10)

Ball bearing assemblies (4 and 22) are permanently lubricated type requiring no additional lubrication during life of the bearing.

Assemble mechanism and install as follows:

1. Install bearing (22) in lever (24) and retain with snap ring (23).

2. Place spring and ball (poppet, 14) in gearshift lever and assemble lever (15) onto collar (13) by installing pin (8) through the two parts.

3. Insert tube (29) through needle bearings (9 and 21), assemble seal washer (19), felt (18) and cup (17) on upper end of tube, then drive key into keyway. Install upper lever (16) and retain with clamp bolt.

4. Hold upper lever (12) and gearshift lever and collar assembly inside housing, then insert shaft (2) upward through tube (29), needle bearing (7) and lever (12). Drive key into slot in shaft and keyway in lever (12).

5. Install bearing assembly (4) on upper end of shaft (2) and retain with snap ring (10). Install and tighten cap (3).

6. Assemble springs and balls (poppets) (6) and retainers (5) in housing.

7. Support housing assembly in inverted position and install washer (19), felt (18), and cup (17) over tube. Place key in keyway in tube, then drive lever (24) and bearing assembly onto tube and shaft. Install clamp bolt to retain lever (24). Bolt must engage notch in tube.

8. Install Woodruff key in keyway in lower end of shaft (2), then drive lever (27) onto shaft. Install clamp bolt through lever (27) - bolt must fit into notch in shaft. Tighten clamp bolt in upper lever (12).

9. Set housing and control assembly into place in vehicle. Be sure steering column grommet is in place and in good condition. Bolt housing into place at instrument panel, and install two mounting bolts at lower end of housing.

10. Connect rods (26 and 28) to respective levers, then check operation of gearshift lever.

11. Connect directional signal wiring and install switch plate on housing.

12. Install removeable cover over steering gear below instrument panel, and install housing cover (cap) on housing.

13. Install steering wheel.

ASSEMBLY REPAIR

Key numbers in text refer to figure 1, 2, and 4 except as indicated in text.

TRANSMISSION DISASSEMBLY

(Refer to Fig. 1)

Procedures for disassembling and assembling transmission as outlined in succeeding paragraphs should be followed carefully to accomplish overhaul of transmission with minimum effort and time. In addition to the tools, necessary receptacles for cleaning the parts and air pressure for blowing out particles of dirt should be available. Parts should be cleaned thoroughly for inspection and reassembly.

Mount unit rigidly on a suitable stand and proceed as follows:

1. Remove main case cover (24) with shift forks and shafts. Remove oil pump from rear f transmission.

2. Remove mainshaft rear bearing cap (70). Cap has two slots at outer edge so that screw driver may be used to pry cap from retainer (67). Do not use extreme force when prying cap. Note quantity of shims (74) used between cap (70) and retainer (67). Tag shims so that original pack may be used when reassembling.

3. Lock mainshaft by engaging both first and third speed gears.

4. Straighten out lips of lock washer (73) and remove mainshaft rear bearing nut (72) with special wrench (Tool No. CS 1075). This nut has left-hand threads and is marked with letters L.H. to distinguish it from countershaft nut.

5. Remove rear bearing retainer (67) with bearings. Retainer is provided with tapped holes in which puller screws may be used. Note quantity of shims (75) used between retainer and angle drive case cover (59). Tag shims so that original pack may be used when reassembling.

6. Remove angle drive case cover (59). Two dowel pins are used to locate angle drive case cover to angle drive case (58).

7. Remove angle drive case (58) with angle drive gear and shaft assembly (65) from main case (9).

8. Remove lock wire and stud nuts which at-'ach clutch housing to transmission; then remove clutch housing, together with clutch release parts.

9. Tapped hole in rear end of reverse idler shaft is provided to withdraw shaft from case. As shaft is withdrawn, gears, bearings, spacers and thrust washers will be stripped from shaft.

10. Pull mainshaft bevel pinion (64) from mainshaft with special puller. (Tool No. CS 1048). Puller must grasp pinion firmly or pinion teeth will be damaged. Spacer (66) will be removed as pinion is pulled from mainshaft.

11. Remove mainshaft center bearing retainer (110) with bearing (42) and thrust washer (40). Retainer has slots on outer edge so that screw driver may be used to assist in its removal. Bearing and thrust washer may be pressed from retainer if necessary after removing bearing snap ring.

12. Remove main drive gear bearing cap (7) and oil seal (1).

13. Remove main drive gear (2) with bearing (5) and bearing retainer (8). Pry lightly between main drive gear and third and fourth speed sliding clutch (18) to start drive gear bearing retainer from case. Remove pilot bearing (11) from mainshaft.

14. Tie mainshaft gears together to hold them in place while removing mainshaft from case. Lift mainshaft and gears from case.

15. Straighten lips of lock washer (83) and remove countershaft rear bearing lock nuts (84 and 82).

16. Force countershaft (87) towards rear until rear bearing retainer flange is exposed, then pull rear bearing (85) and retainer (86) from countershaft.

17. Remove first speed gear (89) and thrust washer (88) from countershaft out through bearing hole in case.

18. Move countershaft towards rear until shaft clears front bearing (104), then remove countershaft with gears out through top of case.

DISASSEMBLY OF SUBASSEMBLIES

REMOVING MAINSHAFT GEARS

1. Untie gears and remove first speed gear (39), first and second speed sliding clutch (32) and third and fourth speed clutch (18).

2. Raise tangs on lock washers (13) and remove lock nut (12) from end of mainshaft.

3. Balance of gears with thrust washers, bearings and spacers may be stripped from mainshaft.

REMOVING GEARS FROM COUNTERSHAFT

1. Remove low speed gear sliding clutch (91).

2. Remove front bearing nut (106) and washer (105).

3. Remove front bearing inner race (104) and retaining washer (103). Bearing and outer race need not be removed unless bearing is to be replaced. In that event, use a suitable driver to remove bearing from case.

4. Drive gear (101), spacer (99) and third speed gear (97) may be pressed off countershaft.

TRANSMISSION

ANGLE DRIVE GEAR AND SHAFT (Fig. 1)

1. Remove propeller shaft flange nut (43) with special wrench, (Tool No. CS 1076).
2. Remove propeller shaft flange (44) with special puller, (Tool No. CS 1062).
3. Remove bearing cap (45) with oil seal (46). Slots are provided in cap so screw driver may be used to pry it off.
4. Remove bearing retainer (50) with special Puller, (Tool No. CS 1128), with outer bearing (48) and inner bearing cup (54). Tapped holes are provided in retainer so that puller screws may be used to remove it. Note quantity of shims (51) used between bearing retainer and angle drive case (58). Tag shims so that original pack may be used when reassembling. Also note quantity of shims (52) used between bearings (48 and 54). Tag these as well so that original pack may be used when reassembling.
5. Remove speedometer driven gear (56) and sleeve.
6. Remove bevel drive gear (65) from angle drive case.
7. Inner tapered bearing (54), speedometer drive gear (55), spacer (57) and straight bearing (60) may be stripped off shaft.
8. Bearing (60) outer race may be removed from case after snap ring (61) has been removed.

TRANSMISSION MAIN CASE COVER DISASSEMBLY (Refer to Fig. 4)

1. Remove shift rod end plate (6).
2. Remove shift fork clamp screws.
3. Remove shift rods (12, 4 and 7) from cover stripping off forks (20, 18, and 8) and stop sleeves (30, 31 and 14) as rods are removed.
4. Remove plug (1) from cover (13) and strike cover sharply on block of wood to remove interlock pins (3 and 5).
5. Remove lock from groove in 3rd and 4th shift shaft (10), then pull duo-speed governor lever (fig. 9) off end of shaft, and remove Woodruff key.
6. Remove clamp screws from third and fourth speed shift finger (9), drive finger over to expose Woodruff key and remove key. Shaft (10) with lever (12) may then be removed from cover.
7. Remove pin (24) from first, second, and reverse shaft (17) and remove collar (25).
8. Remove clamp screw from first, second and reverse shift finger (19).
9. Remove shaft (17) with lever (15) from cover, stripping off reverse spring (28) washers (27 and 29) and finger (19). Finger is held to shaft with key.
10. Solenoid shift lever (23) may be removed from cover by removing lever screw (22).
11. Guide (fig. 9) may be removed from cover after lock nut has been removed.

CLEANING AND INSPECTION

Clean all parts carefully in gasoline or suitable cleaning fluid and blow dry with compressed air.

All bearings should be cleaned thoroughly. After bearing assemblies have been soaked in cleaning fluid, tap them sharply on a block of wood to dislodge any solid particles. Slush them again in cleaning fluid and blow dry with air. Do not spin the bearings with the air - revolve them slowly in races with fingers as air is directed at right angles to the balls or rollers. Examine races and bearings for pits and scores, then oil each assembly thoroughly with clean engine oil.

Individual needle bearing rollers which were removed from main shaft gears should be thoroughly washed and inspected. Replace those bearing rollers which show signs of scores or pits (There are 138 rollers to each gear).

Examine teeth on all gears carefully for nicks and worn spots. Do not take chances with gears which are appreciably nicked or scored. Small nicks may be carefully removed with a "slip-stone" or hone.

Clean interior of main case thoroughly. Remove magnetic drain plug and clean all particles of metal from magnet. Blow out all oil passages with compressed air.

TRANSMISSION CASES AND DOWEL PINS

Clutch housing and transmission angle drive case are held in proper alignment with transmission main case by dowel pins (fig. 11). Two dowels (3) are used at front of main case and two (4) are used at rear of the main case. Angle drive case cover (6) which supports mainshaft rear bearing is also dowelled onto angle drive case.

In the original assembly the transmission serial number appearing on main case name plate is also stamped on angle drive case and cover. It is of utmost importance when assembling transmission that transmission cases are not interchanged with corresponding parts from other transmission. ALWAYS MATCH CASES BY REFERRING TO SERIAL NUMBER.

SERVICE INFORMATION

Transmission main cases, angle drive cases and covers and clutch housings furnished for replacement are standard production parts. Oversize dowel pins are available and must be used to overcome any possible misalignment of dowel pin holes when a new transmission main case, angle drive case, cover, or clutch housing is being assembled with original parts or vice versa.

Before installing oversize dowel pins, it will be necessary to enlarge and ream existing holes with parts bolted together in correct relationship.

MAIN CASE TO ANGLE DRIVE CASE OVERSIZE DOWEL INSTALLATION

Accomplish the following operations when a new angle drive case is to be installed on original main case or vice versa.

1. Install mainshaft center bearing retainer in counterbore at rear of main case. With angle drive case attaching studs in place, place angle drive case on main case and install stud nuts. Tighten stud nuts evenly and firmly to draw the cases together. Mainshaft center bearing retainer will act as a pilot to assure correct position of angle drive case on main case.

2. Using a drill slightly smaller than oversize dowel pin diameter, enlarge the dowel pin holes. Then ream dowel pin holes to size given in "Specifications" at end of this section.

3. Remove stud nuts and separate the two cases; then add counterbore in angle drive case to accommodate oversize dowel pin snap rings (8, fig. 11).

4. Press or drive oversize dowel pins into holes in main case with snap rings contacting surface of case.

ANGLE DRIVE CASE COVER INSTALLATION (Fig. 1)

Accomplish the following operations in the event that new angle drive case is to be installed with original angle drive case cover or vice versa. Perform operations which follow with transmission drive gear and mainshaft installed in main case and the angle drive case assembled on main case.

1. Press mainshaft rear bearings (68 and 69) into retainer (67) then bolt bearing and retainer assembly and cap (70) onto angle drive case cover.

2. Install angle drive case cover on angle drive case, guiding rear bearing over rear end of mainshaft to locate cover on case. Strike angle drive case cover with soft faced hammer to seat cover against angle drive case then install stud nuts finger tight. Rotate mainshaft to insure positive alignment of cover with mainshaft, then tighten cover retaining nuts.

3. Using a drill slightly smaller than standard dowel pin diameter (Refer to "Specifications)" drill new dowel pin holes through pin boss in cover and into angle drive case to depth of at least 1 inch, being careful to avoid original holes.

4. Line ream new holes to .6525 to .6550 inch then remove cover and enlarge holes in cover to .6565 to .6570 inch.

5. Remove angle drive case cover and press or drive oversize dowel pins into new holes in angle drive case.

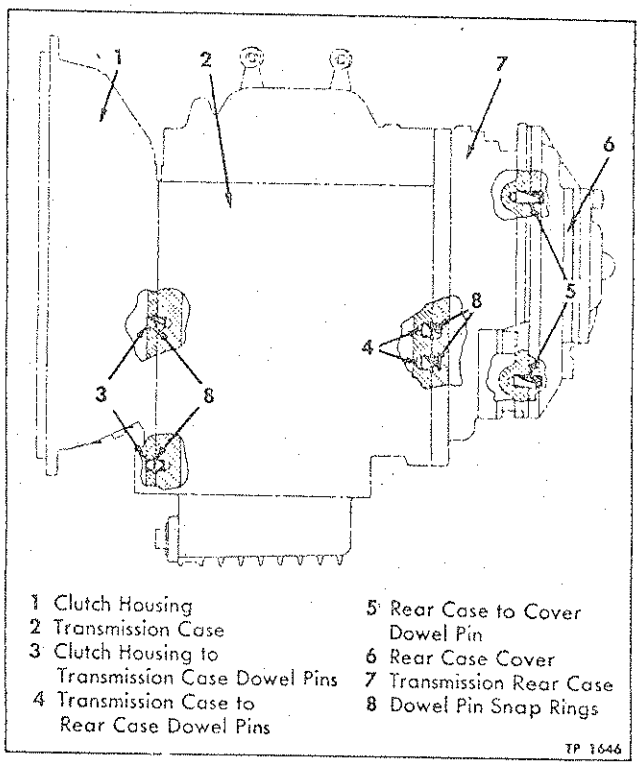


Figure 11—Transmission Case Dowel Pins

CLUTCH HOUSING (Fig. 1)

If clutch housing is replaced with new part, ream dowel pin holes in new part to size in "Specifications" at end of this group, using bearing cap (7) installed on main case as a pilot for locating clutch housing.

TRANSMISSION SUBASSEMBLY BUILD-UP

Procedures as outlined in following paragraphs should be followed in order to assemble transmission with minimum time and effort.

ASSEMBLING COUNTERSHAFT & GEARS (Fig. 1)

Proceed to assemble transmission as outlined in following paragraphs.

1. Press third speed countershaft gear (97) on shaft. Make certain that both keys are in position and key ways are free from burrs.

2. Place spacer (99) and keys (100) in position and press drive gear (101) into place.

3. Install drive gear retaining washer (103) with recessed edge towards bearing (104).

4. Install front bearing inner race (104), retaining washer (105) and nut (106). Tighten nut securely and install cotter pin.

5. Install front bearing (104) into case if it has been removed.

6. Install sliding clutch (91) over countershaft

TRANSMISSION

clutch gear (94). Do not install first speed gear (89) at this time.

MAINSHAFT AND DRIVE GEAR ASSEMBLY (Fig. 1)

1. Place mainshaft in vise with rear end of shaft down (vise should be equipped with "soft" jaws).

2. Make sure second speed gear (30) is thoroughly clean especially on inside diameter then apply a coat of heavy gear oil. Place gear over mainshaft in position shown in figure 1.

3. Install 69 roller bearings (28) in hub of gear. Install bearing spacer (29) and push bearings and spacer in position. Then install top row of roller bearings.

4. Install third speed gear thrust collar (27) and install third speed gear (22) and bearings (20) in same manner as second speed gear. There are 69 roller bearings used in each row.

5. Install third and fourth speed clutch gear (14) over splines of main shaft. Install sliding clutch (18) over gear (14).

6. Install washer (13) and retaining nut (12) and tighten firmly.

7. Lock nut with lock washer.

8. Reverse position of shaft in vise and install first and second speed sliding clutch (32).

9. Install first gear (39) over mainshaft, inserting roller bearings (36) and spacer (38) in same manner as second and third speed gears.

10. Remove mainshaft with gears from vise.

11. Coat inner face of thrust washer (40) with grease and place in position. Grease will prevent washer from sliding out of place when assembly is lowered into case and in that manner prevent bearings from falling out when shaft is tilted for installation. It is also a good plan to temporarily wire the two large gears together to hold them in place while installing shaft.

12. Press bearing (5) into retainer (6), then install the assembly on main drive gear (2).

13. Install lock washer (4) and nut (3). Tighten nut securely and bend tangs of lock washer over flats of nut.

OIL PUMP (Fig. 1)

Oil pump may be readily assembled in following manner:

1. Insert hexagonal drive shaft (80) in end of countershaft (87).

2. Install gasket and oil pump housing (81) over studs and drive shaft (80).

3. Install drive gear (79) in housing (81), with drive bushing end of gear over drive shaft (80).

4. Press driven gear shaft (76) into cover (78) if it has been removed.

5. Assemble driven gear (77) over shaft (76).

6. Fill cover and housing with lubricant and assemble cover with gasket to housing.

7. Install nuts with lock washers and tighten securely.

8. Fill pressure relief valve hole with lubricant and rotate drive shaft (80) in proper direction while filling until all passages are filled with lubricant, and air is displaced. Unless oil pump is filled with lubricant, it may not pick up when first started, thereby changes of damage to transmission through lack of lubricant are increased.

9. Install pressure relief valve ball (109) spring (108) and plug (107).

10. Lock plug with lockwire.

ANGLE DRIVE GEAR AND SHAFT (Fig. 1)

1. Install drive gear straight roller bearing (60) on shaft. Be sure bearings seats firmly against gear.

2. Install spacer (57), speedometer drive gear (55), inner tapered roller bearing cone (54), spacer (53) and original shim pack (52).

3. Install bearing cups (54 and 48) in retainer (50). Be sure cups are firmly seated against shoulder of retainer.

4. Place retainer (50) with bearing cups over inner tapered bearing cone (54) and install outer tapered bearing cone (48).

5. Install propeller shaft flange (44) and nut. Tighten nut securely.

6. Correct bearing adjustment will allow retainer (50) to turn freely but not spin. Increase or decrease shim pack (52), between bearing cones, as necessary to provide correct bearing adjustment.

7. Remove nut (43), propeller shaft flange (44) and retainer (50) with outer bearing (48). Protect shim pack (52) so it will not be disturbed until assembled in case.

8. Install straight roller bearing outer race (60) and snap ring (61) in angle drive case if they have been removed.

9. Place bevel gear and shaft (65) in position in angle drive case (58) and install retainer (50) with original shim pack (51) and outer bearing (48). Do not install bearing cap (45).

10. Install propeller shaft flange (44) and tighten nut (43) securely.

TRANSMISSION MAIN CASE COVER
(Key numbers refer to figure 4, except as noted).

1. Install first, second, and reverse shaft (17) and lever (15) into cover (13), assembling shift finger key, shift finger (19), finger clamp screw washer (29), reverse lock-out spring (28) and washer (27) as shaft is moved into position. Refer to figure 4 for position and relation of parts.

2. Install solenoid shift lever collar (25), and pin (24) in end of shaft.

3. Install third and fourth speed shift shaft (10) and lever (12) into cover and assemble finger

key, shift finger (9) and clamp screw.

4. If guide (8, fig. 9) has been removed from cover install same as shown.

5. Drive Woodruff key into slot in end of shifter shaft (10) then install duo-speed governor lever and retain with lock installed in groove (fig. 9).

6. Insert third and fourth speed rod poppet spring, plunger and poppet in cover (13). Third and fourth rod is upper rod in figure 4, or right-hand rod when transmission is installed in vehicle and may be identified by three poppet notches closely spaced with recesses for fork clamp screws nearer poppet notches.

7. Insert 3rd and 4th speed rod (7) into cover (13) assembling spacer (14) and fork (8) as shown in figure 4, as rod is moved into position.

8. Install fork clamp screws and tighten securely.

9. Shift 3rd and 4th speed rod into neutral, install interlock pin (5) moving it down to rod (7).

10. Insert 1st and 2nd speed rod poppet spring, plunger and poppet in cover (13). First and 2nd rod is center rod and may be identified by three poppet notches closely spaced with recesses for fork clamp screws farther away from poppet notches.

11. Insert 1st and 2nd rod (4) into cover assembling fork (18) and spacer (31) as shown in figure 4 as rod is moved into position.

12. Install fork clamp screw and tighten securely.

13. Shift 1st and 2nd speed rod into neutral, install interlock pin (3) and move it down to rod (4).

14. Insert reverse rod poppet spring, plunger and poppet into cover. Reverse rod is bottom or left-hand rod and may be identified by having only two poppet notches.

15. Insert reverse rod (2) into cover assembling fork (20) and spacer (30), as shown in figure 4, as rod is moved into position.

16. Install fork clamp screw and tighten securely.

17. Install interlock pin plug (1) in cover.

18. Install shift rod end cover gasket and cover (6).

TRANSMISSION ASSEMBLY

Accomplish operations which follow in sequence given, referring to figures 1, 2, & 4 for position of parts.

COUNTERSHAFT INSTALLATION

1. Place countershaft and gear assembly into case, tilt front end upward and lower rear end into case, inserting rear end through rear bearing hole in case far enough to permit front end to be inserted into front bearing (104).

2. Install first speed gear (89) on countershaft by inserting gear through rear bearing hole in case.

3. Install thrust washer (88), recessed edge towards bearing (85).

4. Press rear bearing (85), into retainer (86). Be sure retainer dowel pin is in place, then install bearing and retainer, being careful to align notch in retainer with dowel pin in case.

5. Install inner lock nut (84) and tighten securely.

6. Install lock washer (83) and outer nut (82). Tighten nut and lock both nuts by bending lips of washer over flats of nuts.

REVERSE IDLER GEAR INSTALLATION

Refer to figure 2 and note position and width of spacers installed, at ends and in between roller bearings. Install reverse idler shaft in following manner:

1. Drive shaft into case just far enough to install thrust washer, driven gear, bearings and spacers. Make sure that oil passages in shaft are clean and that plug in end of shaft is in place.

2. As shaft is driven into case, install remaining parts. Front thrust washer fits in notch in case.

3. After shaft is driven into case, tongue on outer end of shaft must be in vertical position, to register with recess in angle drive case.

MAINSHAFT AND MAIN DRIVE GEAR INSTALLATION

1. Tilt front end of mainshaft and gears assembly upward and lower rear end into transmission case and out through center bearing hole in case.

2. Place pilot bearing (11) on front end of mainshaft.

3. Using a new gasket (112) under retainer flange, install main drive gear and bearing assembly in case. Holes through retainer flange must be aligned with tapped holes in case. Also, be sure gasket does not obstruct oil return passage.

4. Install new oil seal (1) in main drive gear bearing cap (7) and replace cap using same thickness of shims (8) as was removed at disassembly. NOTE: Outer race of bearing (5) must be held tight by bearing cap (7). The thickness of shims (8) should be .002 inch less than space existing between bearing cap (7) and retainer flange when measured with a feeler gauge.

5. Insert main drive gear (2) and bearing (5) assembly into place and while working main drive gear bearing retainer into case, hold mainshaft in alignment so that pilot bearing (11) will enter pocket of main drive gear. In order to facilitate assembly of main drive gear, one person should hold mainshaft in alignment, while other is in-

stalling drive gear and bearing.

6. Remove thrust washer (30) at rear end of mainshaft and install center bearing retainer (110). NOTE: This bearing retainer is located on case with one dowel driven into case. Dowel fits in a milled recess in retainer. The other slots or recesses in retainer are for the purpose of removing part.

7. Reinstall thrust washer (40), recessed edge towards bearings, and press center bearing (42) into place.

8. Install bevel pinion spacer (62) over rear end of mainshaft. Spacer is available in three sizes. See "Specifications" at end of this section.

9. Replace bevel pinion keys (63) and install bevel pinion (64).

ANGLE DRIVE (Fig. 1)

1. Angle drive case (58) is held to main case (9) by studs. Cases are located and held in alignment by dowel pins held in place by snap rings. Install new gasket and assemble angle drive case, with bevel gear and shaft, to main case. Make sure that pinion (64) and gear (65) teeth are matched as marked, that dowel pins are in place and that milled end of reverse idler shaft fits into milled slot in case. NOTE: In the event new angle drive case or main case is being installed, ream dowel pin holes in new part to size shown in "Specifications" at end of this section.

ANGLE DRIVE CASE COVER (Fig. 1)

1. Install angle drive case cover (59) using new gasket. Be sure dowel pins are in place. Draw studs up evenly and securely. NOTE: Be sure dowel pins are in good condition.

MAINSHAFT REAR BEARING (Fig. 1)

Mainshaft Rear Bearing Adjustment (Fig. 1)

Correct adjustment of mainshaft rear bearing is obtained in following manner:

1. With bearing retainer (67) removed from transmission, install bearings (68 and 69) and cups in retainer.

2. Assemble bearing cap (70) with original shims (74). Attach cap to retainer with suitable bolts.

3. Increase or decrease shims (74) between cap (70) and retainer (67) until retainer will turn freely on bearings but will not spin.

4. Disassemble and protect shims selected for use at reassembly.

Installing Mainshaft Rear Bearing

1. Install mainshaft rear bearing spacer (66).

2. Install rear bearing retainer (67) with inner bearing cup. Do not install shims (75) between retainer and angle drive case cover (59).

3. Install bearing cones (68 and 69), lock washer (73) and nut (72). Draw nut up tightly.

4. Install puller screws in tapped holes in retainer (67).

5. While holding inner rear bearing (68) tight against its cup, adjust puller screws in retainer (67 until mainshaft and countershaft gears line up).

6. Measure space between retainer (67) and cover (59) with feeler gauge and select proper thickness of shims (75). If this thickness becomes greater than .035 inch, remove pinion (64) and replace spacer (62) with one of sufficient thickness to bring shim pack thickness to less than .030 inch.

7. Remove retainer (67) and reassemble, installing shims selected.

8. Install outer bearing cup (69) and cap (70) using shims (74) between cap and retainer as previously determined when bearing adjustment was made.

9. Check alignment of gears again.

ANGLE DRIVE GEAR BACKLASH (Figs. 1 and 12)

1. With transmission completely assembled with the exception of shims (51) between drive gear outer bearing retainer (50) and angle drive case (58) also bearing cap (45) not assembled, install puller screws in bearing retainer (50) and adjust backlash to dimensions shown on gears. If backlash dimensions on gears are not legible, adjust to .008 - .010 inch. See backlash sketch in bottom corner of figure 12.

2. Measure space between retainer (50) and angle drive case (58) with feeler gauge.

3. Select proper shim thickness and install shims, assembling retainer (50), bearing (48) cap (45) with new oil seal (46), flange (44) and nut (43).

4. Tighten flange nut (43) and cap stud nuts (47) securely.

5. Check backlash in gears again and correct if necessary by adding or removing shims (51).

ANGLE DRIVE GEARS TOOTH CONTACT (Figs. 1 and 12)

1. To check for proper tooth contact paint several teeth on pinion (64) with ground red lead mixed with a few drops of engine oil. Rotate mainshaft by hand in same direction as when operating in forward speed, applying tension at propeller shaft flange at same time. Gears may be seen through filler hole in top of angle drive case (58).

2. Tooth contact impression should start at toe of tooth and extend back about 80% of tooth length toward heel on drive side of tooth. Contact should be distributed evenly over flank and face of tooth, indicating center of contact on pitch line. Refer to diagrams "A" and "B" in figure 12.

3. If tooth contact is too far out on tooth (diagram "C" figure 12), reduce shim thickness

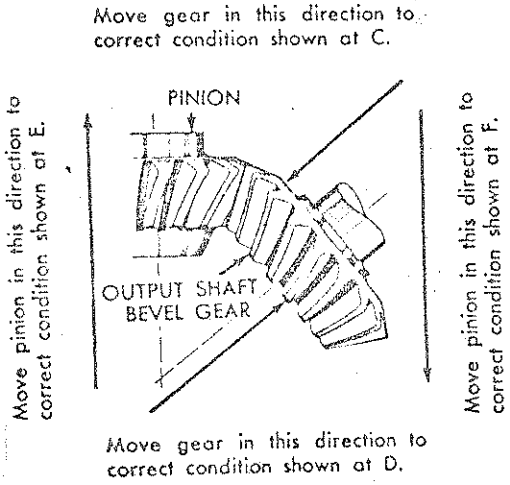
INSTRUCTIONS

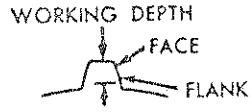
1—Install mainshaft and angle drive output shaft assemblies; then adjust pinion and bevel gear for proper backlash as directed in "Adjustments" paragraph of this section.

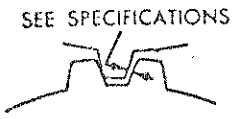
2—Paint three of four teeth of bevel gear on output shaft with red lead or mechanics' blue and rotate pinion until bevel gear makes complete revolution.

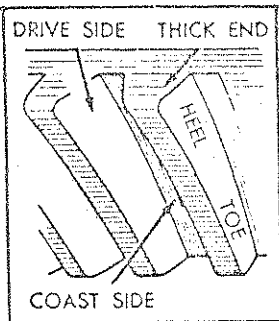
3—Note area of tooth contact which should start at toe and extend about 80 percent of tooth length toward heel, as at B.

4—Vary position of pinion and gear as per chart until proper tooth contact is obtained. Be sure that sufficient backlash has been allowed so that gear can be completely revolved without any highspots being felt.

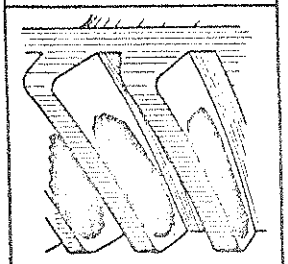




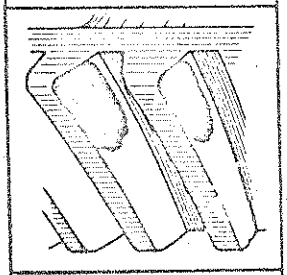




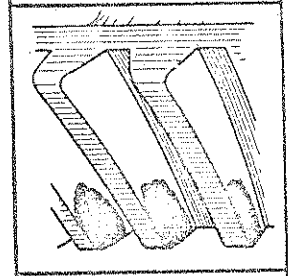
A—Check adjustments at drive side of bevel gear tooth.



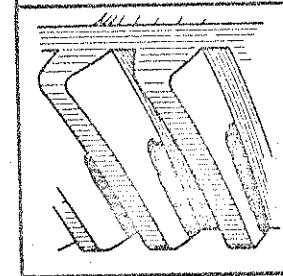
B—Shows correct tooth contact.



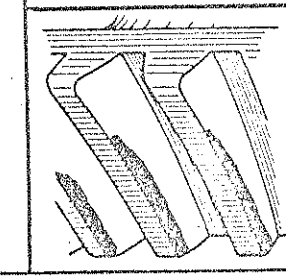
C—Shows short contact at heel. To correct, move gear toward pinion. Then move pinion away from gear to again secure correct backlash.



D—Shows short contact at toe. To correct, move gear away from pinion. Then move pinion toward gear to again secure correct backlash.



E—Shows heavy contact on flank or lower portion of tooth. To correct, move pinion away from gear until contact comes to full working depth of gear tooth without breaking contact at flank. Then move gear toward pinion to secure correct backlash.



F—Shows heavy contact on face or upper portion of tooth. To correct, move pinion toward gear until contact covers flank of tooth without breaking contact at face. Then move gear away from pinion to secure correct backlash.

YP 0988

Figure 12—Angle Drive Gear Tooth Contact Chart

at (51) between bearing retainer (50) and angle drive case (58) moving gear (65) towards pinion (64). Restore backlash by adding shims at (75) between bearing retainer (67) and angle drive case cover (59).

4. If tooth contact extends back from toe appreciably less than 80% of tooth length (diagram "D" figure 12), move gear (65) away from pinion (64) by adding shims at (51). Restore backlash by reducing shims at (75).

5. If contact is low on flank of tooth (see diagram "E" figure 12) move pinion (64) away from gear (65) by reducing shims at (75). Restore backlash by adding shims at (51).

6. If contact is high on face of tooth (diagram "F" figure 12), move pinion (64) towards gear (65) by adding shims at (75). Restore back lash by reducing shims at (51).

OIL PUMP INSTALLATION

1. Using new oil pump gasket, install pump assembly on transmission, guiding drive shaft (80) into socket at rear of countershaft (87).

TRANSMISSION COVER INSTALLATION

1. Place levers (25 and 37) in neutral and move clutches (18, 32, 91 and 93) to neutral position.

2. With new cover gasket in place, lower cover assembly onto transmission case so that forks enter grooves in clutches.

3. Bolt cover in place. Install reverse solenoid assembly and lever (fig. 8) on transmission cover, and adjust solenoid linkage.

SPECIAL TOOLS

Reference is made to special tools and their use is illustrated in this section. These tools, or their equivalent, are necessary and are recommended to more readily and efficiently accomplish certain service operations. The tools, however, are not supplied by the coach manufacturer. Names and addresses of vendors or manufacturers are shown as a reference, and since such vendors are the suppliers of these tools, information regarding availability, price, etc., should be obtained directly from them.

Tool No.	Name
CS-1075	Mainshaft Rear Bearing Nut Wrench
CS-1048	Bevel Pinion Puller
CS-1076	Flange Nut Wrench
CS-1062	Flange Puller
CS-1128	Bearing Retainer Puller

Vendor's Name	Address
Curtiss & Smith Mfg. Corp.	Pottstown, Pennsylvania

SPECIFICATIONS

SPICER MODEL NUMBERS ..... 7141 and 7141-A

Speeds ..... Four Forward - One Reverse
Mounting ..... Unit
Gear Selection ..... Manual, Remote Control

GEAR RATIOS

Spicer Model	7141-A	7141
Angle Drive Gears	1.00 to 1	1 to 1
First Speed	3.86 to 1	4.36 to 1
Second Speed	2.50 to 1	2.84 to 1
Third Speed	1.50 to 1	1.70 to 1
Fourth Speed (Direct)	1.00 to 1	1 to 1
Reverse	3.29 to 1	3.72 to 1

GEAR BACKLASH

Angle Drive Gears	0.008" - 0.010"
Mainshaft and Countershaft Gears	0.006" - 0.008"
Sliding Clutches and Clutch Gears	0.004" - 0.007"
Oil Pump Gears	0.006" - 0.008"

MAINSHAFT GEAR BEARING ROLLERS

Number of rollers Per Gear	138
Length	0.655" - 0.675"
Lapped Diameter	0.12500" - 0.12525"

BEARING ADJUSTMENTS

Angle Drive Gear Tapered Bearing
- See Instructions

SHIM THICKNESS AVAILABLE

Main Drive Gear Bearing Cap	0.003" - 0.010"
Mainshaft Rear Bearing Retainer	0.010" - 0.031"
Mainshaft Rear Bearing Cap	0.003" - 0.010"
Angle Drive Gear Bearing Cone	0.003" - 0.010" - 0.030"
Angle Drive Gear Bearing Retainer	0.003" - 0.010" - 0.031"

SPACER THICKNESS

Bevel Pinion - Front (Available in 3 Sizes)	0.230" - 0.245" - 0.260"
Bevel Pinion - Rear	0.938" - 0.948"
Angle Drive Gear Bearing Cone	0.373" - 0.377"

THRUST WASHER THICKNESS

Mainshaft 1st Speed Gear	0.262" - 0.266"
Countershaft 1st Speed Gear	0.245" - 0.249"
Reverse Gear - Front	0.182" - 0.187"
Reverse Gear - Rear	0.185" - 0.186"

COUNTERSHAFT 1ST SPEED GEAR BUSHING

Inside Diameter (As Serviced)	2.346" - 2.349"
Inside Diameter (in Place) Grind to	2.3595" - 2.3605"

OIL PUMP GEARS

Width	0.622" - 0.623"

OIL PUMP DRIVE GEAR SHOULDER

Outside Diameter	0.8725" - 9.8755"

OIL PUMP DRIVE GEAR SHOULDER BORE IN COVER AND HOUSING

Inside Diameter	0.8745" - 0.8755"

OIL PUMP DRIVEN GEAR BUSHING

Length	0.610" - 0.620"
Burnish to	0.4990" - 0.5005"
Bushing to Shaft Clearance	0.001" - 0.0035"

PRESSURE RELIEF VALVE SPRING

Free Length	2-7/16"
Pressure @ 2"	3 lbs. 6-1/2 oz. 3 lbs. 9-1/2 oz.

REVERSE SHIFT LOCK SPRING

Free Length	5-1/16"
Lbs. Pressure @ 1-3/4	38 - 42

SERVICE DOWEL PINS AND HOLES

Clutch Housing to Main Case	
Pin Diameter	0.8110" - 0.8120"
Hole Diameter in Both Pieces	0.8070" - 0.8095"
Main Case to Angle Drive Case	
Pin Diameter	0.8110" - 0.8120"
Hole in Both Pieces	0.8070" - 0.8095"
Angle Drive Case to Angle Drive Case Cover	
Pin Diameter	0.6555" - 0.6560"
Hole Diameter in Angle Drive Case	0.6525" - 0.6550"
Hole Diameter in Angle Drive Case Cover	0.6565" - 0.6570"

SERVICE BULLETINS

Service Bulletins are issued, whenever required, supplementing information in this section. The information contained in these bulletins should be noted in the text and bulletin filed for future reference — Make note of bulletin number in spaces below:

NOTES

Propeller Shaft

Contents of This Section

Related Subjects in Other Sections

Propeller shaft used on vehicle covered in this manual (fig. 1) is solid type. The specific shaft assembly used together with service data, is listed under "Specifications" later in this section. Propeller shaft is equipped with heavy duty needle bearing universal joints.

Flange yoke, at slip joint end is bolted to transmission companion flange.

Flange yoke is fixed joint end, is bolted to companion flange at differential.

The shaft is splined to slip yoke and retained in place, by a steel dust cap which screws onto slip yoke. The fixed end of shaft assembly is also splined into yoke and retained in yoke with washer, nut and cotter pin.

Slip joint, at transmission end of shaft, compensates for variations in distance between transmission and differential.

These variations are brought about by the rise and fall of rear axle as the vehicle passes over rough pavement, or uneven terrain. Slip joint also facilitates removal of transmission or power plant.

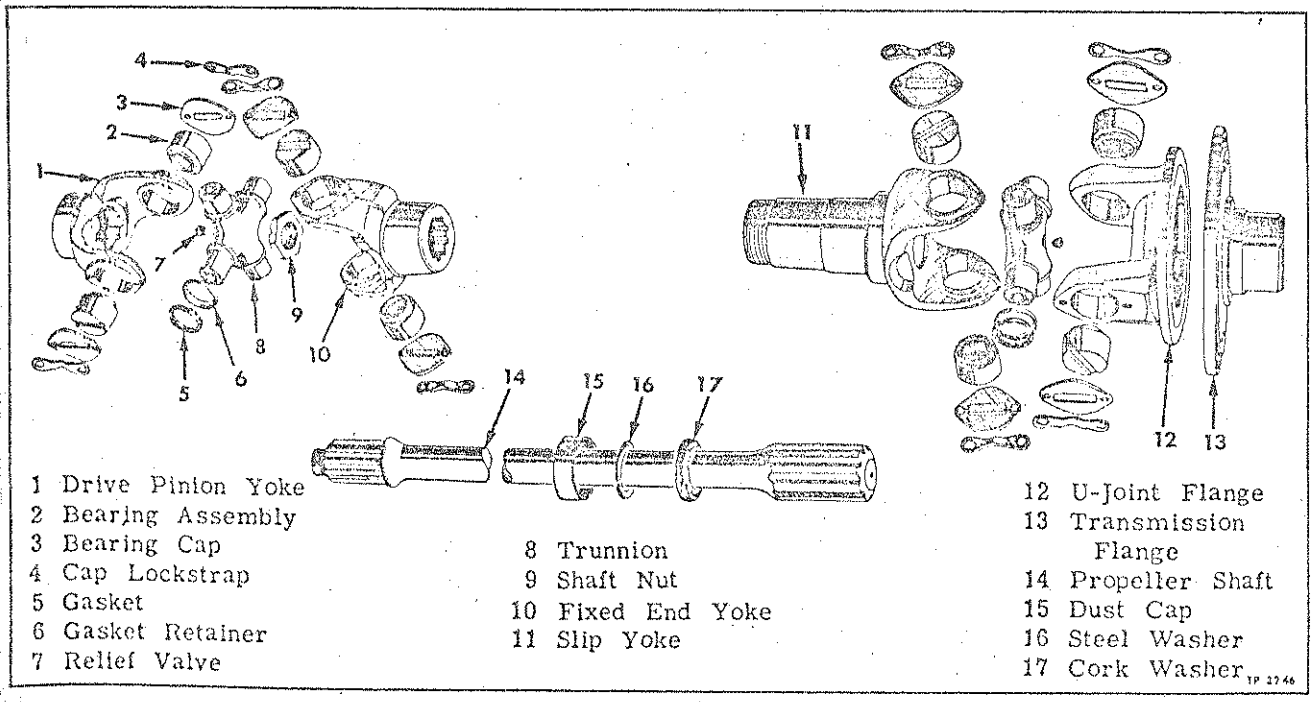


Figure 1—Component Parts of Propeller Shaft

PROPELLER SHAFT

PROPELLER SHAFT REMOVAL

Whenever it is necessary to remove propeller shaft assembly for repair purposes, when transmission and rear axle are in place, removal may be accomplished in the following manner.

1. Remove lock wires, nuts and lock washers that attach propeller shaft companion flanges to companion flanges of transmission and differential.
2. Disassemble slip joint. NOTE: Read instructions given later under "Joint Removal" in this section, before disassembling slip joint.
3. After slip joint has been disassembled, propeller shaft can be removed from vehicle by pulling slip joint end of shaft out through engine access door and by pulling fixed joint end of shaft toward rear axle.

PROPELLER SHAFT DISASSEMBLY

JOINT REMOVAL

Slip yoke and fixed end yoke are marked with aligning arrows when shaft is manufactured and assembled. Before slip joint or fixed joint are removed from shaft, ascertain that arrows on yokes are clear and discernible (fig. 2).

If arrows are not visible, mark both yokes distinctly; then remove dust cap on slip joint. Slip joint can now be removed from shaft. To remove fixed joint from shaft, disassemble universal joint in manner later described under "Universal Joint Disassembly" in this section; then remove cotter pin, nut and washer which secure fixed yoke on shaft.

UNIVERSAL JOINT DISASSEMBLY (Fig. 1 and 4)

1. Remove cotter pins which secure lock straps in place and remove lock straps; then remove cap screws and bearing caps. Drive needle bearing assemblies out of yokes with a flat faced brass drift 1/32 inch smaller in diameter than bearing.

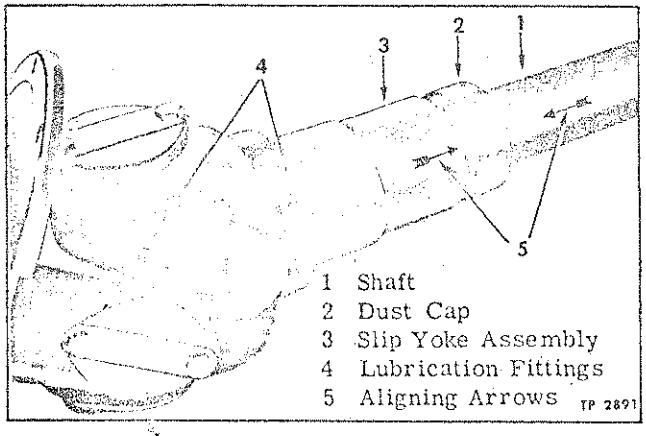


Figure 2—Propeller Shaft With Slip Joint Installed

Place drift on top of bearing and tap drift with a hammer until opposite bearing is out of place. Reposition joint assembly and repeat procedure until all bearings are removed. CAUTION: To prevent damage to bearings, do not permit bearing assemblies to drop on the floor.

2. Slide trunnion side way as far as possible then tilt trunnion until journal clears hole in yoke and remove trunnion from yoke.
3. Remove gaskets and retainers from trunnion journals. Remove lubrication fittings and pressure relief fitting from trunnion.

CLEANING AND INSPECTION

PROPELLER SHAFT

Thoroughly clean splines of shaft, then inspect for wear. See "Specifications" at end of this section.

If shaft is badly warped or broken, it should be replaced. Welding of broken shafts is not recommended since this operation requires special facilities.

SLIP AND FIXED JOINT YOKES

Carefully inspect each yoke for cracks, wear, damage or bent condition. Small burrs or rough spots can usually be removed with a hone. See "Specifications" later in this section, for clearance between shaft and yoke splines. Replace if defective or badly worn. Check expansion plug in slip joint; make certain small lubrication relief hole is open and clean.

UNIVERSAL JOINT

Clean all parts with clean gasoline or other suitable cleaning fluid. Thoroughly clean all lubricant passages in trunnion (fig. 4), lubrication fitting and pressure relief valve. Soak needle bearing assemblies in cleaner to soften particles of lubricant. Clean bearing assemblies using stiff brush, then blow out dirt with compressed air. CAUTION: Be sure bearing assemblies are absolutely clean; even very small particles of dirt or grit can cause excessive bearing wear. Needle type bearing assemblies should not be disassembled.

Inspect journal bearing surfaces for roughness or needle bearing grooves. If grooves and roughness will not clean up with moderate honing, trunnion and bearing assemblies should be replaced. Carefully inspect each bearing assembly for wear or missing bearings, see "Specifications" at end of this section. Excessive wear is indicated if needles drop out of retainer, or if journal bearing surface shows marks of needles. If such conditions exist, needle bearing assemblies should be replaced

After needle bearing assemblies are thoroughly cleaned, work a small quantity of lubricant recom-

mended in Lubrication (Sec. 13 of this manual) into each needle bearing assembly; then place bearings on trunnion journals and check for excessive wear. Refer to "Specifications" at end of this section for limits. If excessive clearance is noted, install new parts as required. Otherwise pack each bearing one third full with lubricant recommended in Lubrication (Sec. 13 of this manual). Inspect gaskets and gasket retainers and replace if not in good condition.

PROPELLER SHAFT REASSEMBLY

UNIVERSAL JOINT ASSEMBLY (Fig. 1)

1. Install pressure relief valve and lubrication fitting in trunnion, next, install gasket retainers and new gaskets on journals.

2. Insert one journal of trunnion into yoke as far as possible from inside, and tilt until opposite journal clears yoke and drops into position.

IMPORTANT: When installing trunnion in yoke at differential end of shaft, position pressure relief valve side of trunnion toward shaft.

3. Before fixed joint at differential end of propeller shaft is assembled, install yoke onto shaft and ascertain that mark on shoulder of shaft aligns with arrow on yoke with yoke in position. Install washer over threaded end of shaft and secure washer in place with nut. Tighten nut firmly; then align slots in nut with cotter pin hole in shaft and install new cotter pin full size of hole.

4. Insert bearing assemblies from outside of yoke and tap into place with rawhide hammer. WARNING: Do not use steel hammer for this purpose.

5. Care should be exercised to assure that joints move freely in the bearings and do not bind. If joints are tight, change the bearings around until joints are free and operate smoothly in the assembled position.

6. Place bearing caps on yokes and install cap screws. Tighten cap screws firmly; then install lock straps over heads of cap screws and secure lock straps in place with new cotter pins full size of holes.

PROPELLER SHAFT INSTALLATION

1. Install slip joint assembly on transmission companion flange, install bolts, new internal tooth lock washers; then tighten bolts alternately and firmly. Insert lock wire through bolts so that if bolts loosen, wire will be drawn tighter. Draw wire taut and secure ends together. Mark alignment arrows with light colored chalk to assist in installation of shaft assembly.

2. Install dust cap, cork washer and steel washer, on slip joint end of shaft (fig. 3). When

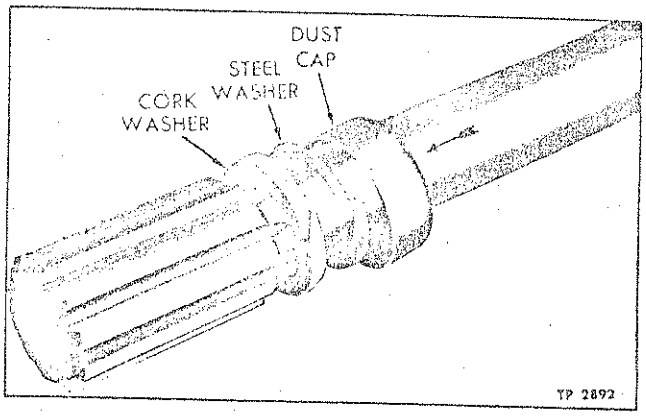


Figure 3—Propeller Shaft With Slip Joint Removed

two steel washers are used. cork washer should be installed in between steel washers.

3. Apply a thin coating of lubricant recommended in Lubrication (Sec. 13 in this manual), on propeller shaft splines slip end. Place shaft assembly in position under vehicle and align arrows on both universal joints; then insert splined end of shaft into slip joint.

4. Position fixed joint on differential companion flange, then install bolts, new lock washers, nuts and new lock wire. Bolts through differential companion flange should be positioned so that nuts will lock against boss on hand brake drum. Install lock wire as previously described in step (1).

5. Position cork and steel washer and screw dust cap onto slip joint, then tighten dust cap

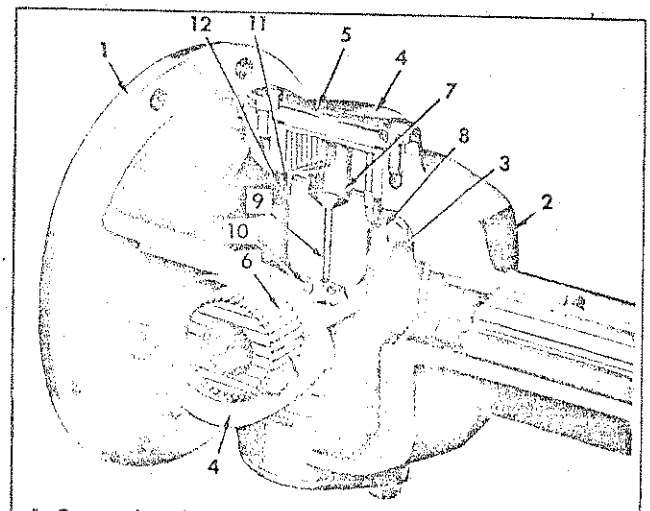


Figure 4—Cross Section View of Universal Joint

PROPELLER SHAFT

hand tight. CAUTION: DO NOT USE WRENCH. Check all nuts, bolts, cap screws, etc., on entire propeller shaft assembly to ascertain that all parts are assembled properly. Lubricate universal joints and slip joint with lubricant specified in Lubrication (Sec. 13 in this manual).

LUBRICATION

Trunnion of universal joints are drilled and provided with pressure gun lubrication fittings, through which the lubricant travels to all four reservoirs (fig. 4) and then through a small hole in the side of each reservoir, direct to the needle bearing assemblies. A pressure relief valve is installed in the central chamber (fig. 4) which prevents damage to the gaskets when extremely high pressure is used in forcing in the lubricant. This valve also serves as an indicator to show when joints are completely filled with lubricant.

Needle bearings are well protected against lubricant leakage and the ingress of foreign matter by the gaskets provided.

Splines of slip joint are lubricated through pressure gun lubrication fitting installed in slip yoke assembly.

Universal joints and slip yoke splines should be lubricated periodically as specified in Lubrication (Sec. 13 in this manual).

SPECIFICATIONS
(New Limits)

Universal Joint Type	Slip Joint 1701 Series	Fixed Joint 1708 Series
Shaft Diameter	2.4975"-1.4980"	1.993"-1.998"
Trunnion Journal Diameter	1.3201"-1.3206"	1.3201"-1.3206"
Number of Rollers	36	36
Diameter of Rollers	.12475"-.12500"	.12475"-.12500"
Length of Rollers	.920"-.925"	.920"-.925"
Yoke Groove Width	.3885"-.3900"	.3105"-.3120"
Shaft Spline Thickness	.3860"-.3875"	.3120"-.3135"
Clearance Between Shaft Splines and Yoke Splines	.001"-.004" Loose	.000"-.003" Tight

Hubs and Bearings

Contents of This Section

Related Subjects in Other Sections

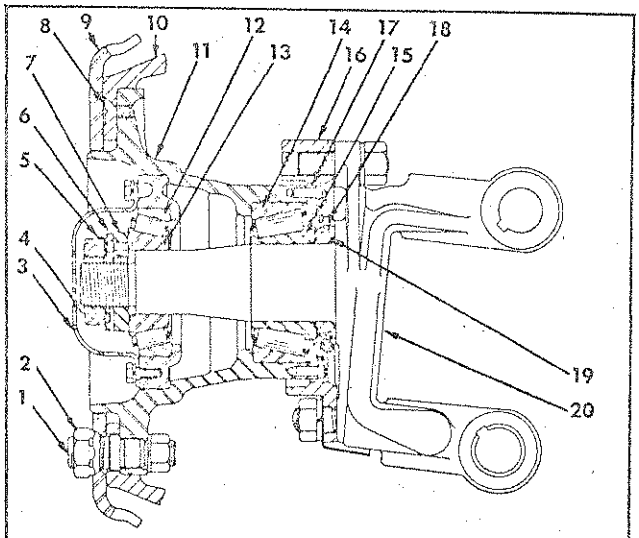
Wheels and hubs are carried on two opposed tapered roller bearings as shown in figures 1 and 2. Bearings are adjustable for wear and their satisfactory operation and long life depend upon proper adjustment and correct lubrication. If bearing adjustment is too tight, bearings will overheat and wear rapidly. Loose adjustment will result in pounding, and will also contribute to steering difficulties, uneven tire wear, and inefficient brakes. Before checking or adjusting wheel bearings, always be sure brakes are fully released and do not drag. Wheel studs are installed in hub flange as shown in figures 1 and 2. Brake drums are mounted over wheel studs on outer side of hub flange and attached to hub with countersunk screws.

BEARING ADJUSTMENT

Wheel bearing adjustment should be checked carefully at each inspection period. Jack up wheels one at a time and check bearing play by using a pry bar under tires. Observe movement of brake drum in relation to brake spider or shoes. If bearings are adjusted correctly, movement of drum will be just noticeable and wheel will turn freely with no drag. If test indicates that adjustment is necessary make adjustments as follows:

FRONT WHEEL BEARINGS (Fig. 1)

1. Remove cap screws and hub cap from hub.
2. Raise lip of nut lock and remove lock nut, nut lock, and lock ring from spindle.
3. Tighten adjusting nut unitl wheel binds, at the same time rotating wheel to make sure all surfaces are in proper contact.
4. Back off adjusting nut 1/6 turn, or more if necessary, making sure that wheel turns freely.



1 Wheel Stud	12 Outer Bearing Cup
2 Wheel Nut	13 Outer Bearing Cone and Roller Assy.
3 Hub Cap	14 Inner Bearing Cup
4 Lock Nut	15 Inner Bearing Cone and Roller Assy.
5 Nut Lock	16 Brake Spider
6 Lock Ring	17 Oil Seal Wiper
7 Adjusting Nut	18 Oil Seal Assy.
8 Brake Drum Screw	19 Bearing Spacer
9 Wheel	20 Steering Knuckle
10 Brake Drum	
11 Hub	

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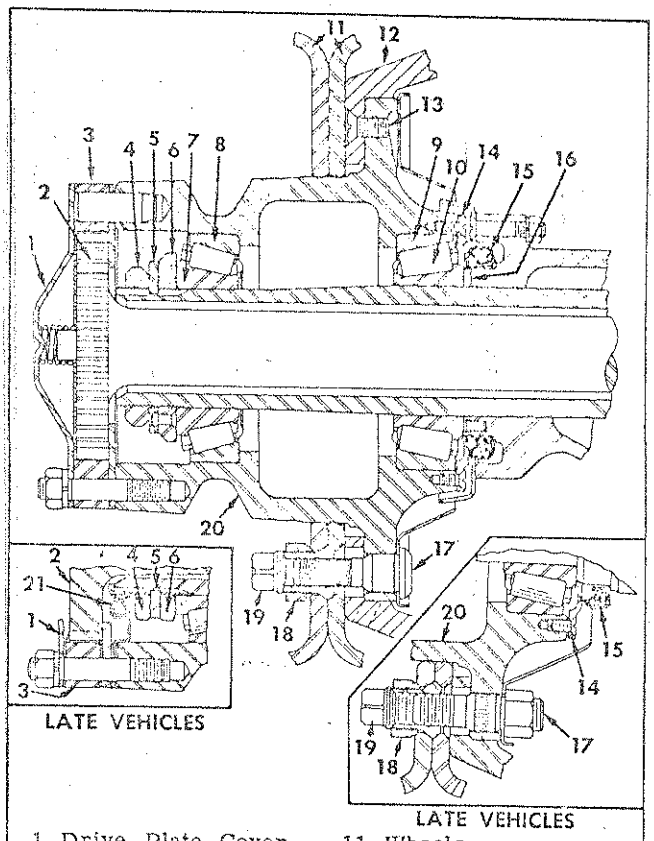
Figure 1—Front Hub and Bearings

5. Replace lock ring with dowel pin in adjusting nut inserted in hole in ring. Either side of ring may be used toward adjusting nut, whichever requires the least change in position of adjusting nut to permit assembly.

HUBS AND BEARINGS



1	Drive Plate Cover	11	Wheels
2	Axle Shaft	12	Brake Drum
3	Drive Plate	13	Brake Drum Screw
4	Lock Nut	14	Oil Seal Wiper
5	Lock Ring	15	Oil Seal Assy.
6	Adjusting Nut	16	Inner Bearing Washer
7	Outer Bearing Cone and Roller Assy.	17	Wheel Stud
8	Outer Bearing Cup	18	Outer Wheel Nut
9	Inner Bearing Cup	19	Inner Wheel Nut
10	Inner Bearing Cone and Roller Assy.	20	Hub
		21	Outer Oil Seal Assy.

Figure 2—Rear Hub and Bearings

6. Install nut lock and lock nut on spindle and draw nut up tight.

7. Recheck bearing adjustment, then bend lip of nut lock down against flat of lock nut. Install hub cap on hub, using new gasket between cap and hub.

REAR WHEEL BEARINGS (Fig. 2)

1. Remove axle shaft as directed in Rear Axle (Sec. 2 of this manual). On vehicles equipped with outer oil seal, remove seal.

2. Remove lock nut and lock ring from axle housing tube. On late type, unscrewing lock nut will force outer oil seal wiper and cork assembly off housing tube.

3. Tighten adjusting nut until wheel binds, at the same time rotating wheel to make sure all surfaces are in proper contact.

4. Back off adjusting nut 1/6 turn, or more if necessary, to make sure wheel turns freely.

5. Install lock ring with dowel pin in adjusting nut inserted in hole in ring. Either side of ring may be used toward adjusting nut, whichever requires the least change in position of adjusting nut to permit assembly.

6. Install lock nut and tighten firmly, then recheck bearing adjustment.

7. On late type, install oil seal wiper and cork assembly on end of housing tube. Make sure wiper fits squarely against end of tube and that the surface against which oil seal lip bears is not distorted. Coat lip of outer oil seal and oil seal wiper with grease, then install oil seal using new gasket between oil seal retainer and hub. Make sure oil seal lip is properly positioned on wiper.

8. Install axle shaft as directed in Rear Axle (Sec. 2 of this manual).

OIL SEALS

Front and rear hubs have oil seals at inner end to prevent leakage of wheel bearing lubricant into brake drum. Inner oil seals also prevent water and dirt from entering the hubs and contaminating the wheel bearing lubricant. Late vehicles also have oil seals at outer ends of hubs to prevent rear axle differential lubricant from entering the hubs and mixing with the wheel bearing lubricant.

Inner seals used in both front and rear hubs are stationary, end face, spring loaded type. Front seals are mounted on bearing spacer on steering knuckle spindle. Rear seals are mounted on shoulder on axle housing. Synthetic sealing surface of seals wipe on oil seal wipers which are attached to inner end of each hub with screws.

Outer seals used in rear hubs on late vehicles are spring loaded lip type seals with integral retainers which fit over axle shaft drive ring studs. Oil seal lip wipes on oil seal wiper which is pressed onto outer end of axle housing tube. Wiper to tube cork gasket is cemented to inner side of wiper.

At regular inspection periods, examine all seals carefully. If there is any indication of wear, deterioration, or damage at the sealing surface, a complete new seal assembly should be installed. Also examine surface of oil seal wipers against which seals bear. Any nicks, scratches, or rough spots on this surface will impair efficiency of seal.

Always spread a thin coating of grease on face of seal and on oil seal wiper before installing on hub.

FRONT HUB AND BEARING REMOVAL (Fig. 1)

1. Raise front end of vehicle until tires just clear floor.
2. Remove wheel stud nuts and remove wheel, then remove brake drum retaining screws and remove brake drum. Remove hub cap.
3. Raise lip of nut lock and remove lock nut, nut lock, lock ring, and adjusting nut from spindle.
4. Pull hub assembly straight off spindle, being careful not to permit outer bearing to fall out.
5. Remove screws attaching oil seal wiper to hub and remove wiper and gasket.
6. Lift inner bearing out of hub.
7. Perform cleaning and inspection operations outlined under "Cleaning and Inspection" later in this section. If inspection indicates the need of replacing oil seal or bearing cups, they may be removed as follows:
8. To remove oil seal, pry it off from bearing spacer on spindle. Bearing cups may be driven out, using a long brass drift through opposite side of hub.

REAR HUB AND BEARING REMOVAL (Fig. 2)

1. Raise rear end of vehicle until tires are just clear of floor.
2. Remove wheel stud nuts and remove wheels, then remove brake drum.
3. Remove axle shaft as directed in Rear Axle (Sec. 2 of this manual). On late type, remove outer oil seal and gasket.
4. Remove lock nut, lock ring, and bearing adjusting nut from axle housing tube. On late type, removing lock nut will force outer oil seal wiper and cork assembly off housing tube.
5. Pull hub assembly straight off axle housing tube.
6. Remove screws attaching oil seal wiper to hub and remove wiper and gasket.
7. Lift inner bearing out of hub.
8. Perform cleaning and inspection operations outlined under "Cleaning and Inspection" later in this section. If inspection indicates the need of replacing inner oil seal or bearing cups, they may be removed as follows:
9. To remove oil seal, pry it off the shoulder on axle housing. Bearing cups may be driven out, using a long brass drift through opposite side of hub.

CLEANING AND INSPECTION

CLEANING

1. Immerse bearing cone and roller assemblies in gasoline or other suitable cleaning fluid. Clean with stiff brush to remove old lubricant. Blow bearings dry with compressed air, directing air stream across bearing. Do not spin bearings while blowing them dry.
2. Thoroughly clean all old lubricant out of inside of hub and wipe dry. Make sure all particles of gasket are removed from inner end of hub.
3. Clean lubricant off axle housing tube (rear) or spindle (front). Wipe lubricant off oil seals, using a clean cloth dampened with cleaning fluid. Do not permit cleaning fluid or grease to get on brake linings.
4. Wash all small parts such as bearing nuts, lock rings, and oil seal wipers in cleaning fluid and wipe dry.

INSPECTION

1. Inspect bearing rollers for excessive wear, chipped edges, or other damage. Slowly roll rollers around cone to detect any flat or rough spots on cone or rollers. Replace bearing assemblies if any part is damaged.
2. Examine bearing cups in hub. If cups are pitted or cracked, they must be replaced with new parts.
3. Carefully examine oil seals for signs of wear, deterioration, distortion, or damage at the sealing surfaces. Replace oil seal assembly if any of the above conditions are evident.
4. Inspect oil seal wipers for nicks or rough spots which would cause rapid wear of seals. Replace with new parts as necessary.
5. After inspection is completed and parts replaced as necessary, lubricate bearings and inside of hub as directed in Lubrication (Sec. 13 of this manual).

FRONT HUB AND BEARING INSTALLATION (Fig. 1)

1. If bearing cups were removed, drive or press new cups into hub with wide side of cups toward inside. Make sure cups are fully seated against shoulder in hub and are not cocked. Make sure bearings and inside of hub are lubricated as directed in Lubrication (Sec. 13 of this manual).
2. If oil seal was removed, drive new oil seal assembly onto bearing spacer. Use extreme care when driving oil seal into place not to distort the seal flange. Make sure seal is seated squarely against shoulder on bearing spacer.
3. Place inner bearing cone and roller assembly in hub, then install oil seal wiper on inner end of hub, using new gasket. Draw wiper retaining screws up evenly and firmly.
4. Coat face of oil seal and oil seal wiper with grease.
5. Install hub assembly on spindle, then place

HUBS AND BEARINGS

outer bearing cone and roller assembly on spindle and push into hub with fingers. Install bearing adjusting nut and draw up finger-tight.

6. Install brake drum and retaining screws, then install wheel as directed in Wheels and Tires (Sec. 19B of this manual).

7. Adjust wheel bearings and complete the installation as previously directed under "Bearing Adjustment" in this section.

REAR HUB AND BEARING INSTALLATION (Fig. 2)

1. If bearing cups were removed, drive or press new cups into hub with wide side of cups toward inside. Make sure cups are fully seated against shoulder in hub and are not cocked. Make sure bearings and inside of hub are lubricated as directed in Lubrication (Sec. 13 of this manual).

2. If inner oil seal was removed, drive new oil seal assembly onto shoulder on axle housing. Use extreme care when driving oil seal into place not to distort the seal flange. Make sure inner bearing washer is in place on axle housing tube and that seal is seated squarely against shoulder on housing.

3. Place inner bearing cone and roller assembly in hub, then install oil seal wiper on inner end of hub, using new gasket. Draw wiper retaining screws up evenly and firmly.

4. Coat face of oil seal and oil seal wiper with grease.

5. Install hub assembly on axle housing tube, then place outer bearing cone and roller assembly on tube and push into hub with fingers. Install adjusting nut and draw up finger-tight.

6. Install brake drum on hub and install retaining screws, then install wheels as directed in Wheels and Tires (Sec. 19B of this manual).

7. Adjust wheel bearings and complete the installation as previously directed under "Bearing Adjustment" in this section.

SPECIAL TOOLS

The following special tools are not supplied by the Coach manufacturer. Name and address of vendor is given as a reference, and information regarding availability, price, etc., should be obtained directly from them.

Tool No.	Tool Name
CS-1109	Front Wheel Bearing Nut Wrench - Outer
CS-1109-A	Front Wheel Bearing Nut Wrench - Inner
CS-1061-A	Rear Wheel Bearing Nut Wrench - Outer (Early Vehicles)
CS-1061	Rear Wheel Bearing Nut Wrench - Inner (Early Vehicles)
CS-1417	Rear Wheel Bearing Nut Wrench - Inner and Outer (Late Vehicles)

Vendor	Address
Curtiss & Smith Mfg. Co.	Pottstown, Pennsylvania

Wheels and Tires

Contents of This Section

Related Subjects in Other Sections

WHEEL MAINTENANCE

Wheel studs and nuts on left side of vehicle all have left-hand threads. Studs and nuts on right side all have right-hand threads. Wheel stud nuts should be inspected and tightened at periodic intervals. Wheel maintenance will be considerably reduced by adherence to following procedure.

1. Before new vehicle goes into service and after each wheel removal, all wheel nuts should be thoroughly tightened. See that nuts are free from grease and oil. Do not use oil on studs or nuts.
2. To tighten nuts on dual rear wheels, loosen outer nuts, then tighten inner nuts. Tighten opposite nuts alternately so that wheel will be square against hub flange. After tightening inner nuts, tighten outer nuts.
3. Re-tighten nuts daily for first 500 miles to offset setting-in of clamping surfaces.
4. Inspect wheel nuts at least every 1,000 miles thereafter. (If vehicle is subjected to severe service, this inspection should be made daily regardless of the mileage).
5. When changing wheels or tires and before assembling wheels to hubs, remove dirt, grease, and excess paint from the mating surfaces.

WHEEL MOUNTING

Dual wheels should be mounted as shown in figure 1. Care should be exercised in positioning tire valves and wheel spokes. By placing spoke openings as shown, access to both outer and inner tire valves may be more readily obtained.

TIRE MAINTENANCE

One of the most important factors of economical and safe motor vehicle operation is systematic and correct tire maintenance. The tires must not only support the weight of the loaded vehicle, but they are also integral parts of the transmission and braking systems. Therefore, the tires should receive careful, systematic, and regular maintenance as do other operating units. The three major causes of tire trouble are (1) under-inflation, (2) bruises, and (3) misalignment. Tires should be checked periodically for these conditions.

INFLATION OF TIRES

Under-inflation is the greatest cause for loss of tire life expectancy. Tires should be checked frequently for this condition. The fabric, rubber, bead, contour, and size of tires used on these vehicles are designed to obtain maximum length of service under all operating conditions to which vehicles may be subjected. TIRES ARE DESIGNED

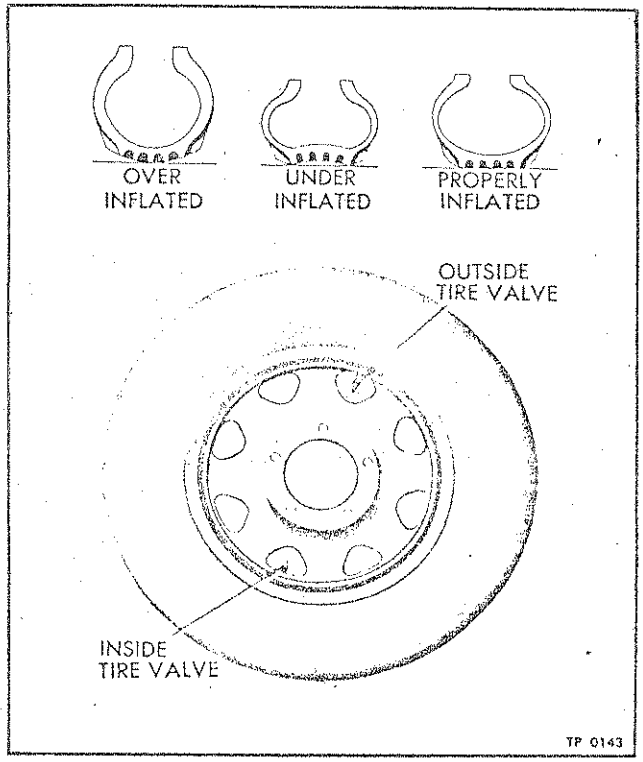


Figure 1—Tire Inflation and Dual Wheel Tire Valve Location

WHEELS AND TIRES

TO OPERATE EFFICIENTLY ONLY ON A PRESCRIBED AMOUNT OF AIR. Unless the correct air pressure is consistently maintained, the tires will not function as they should; consequently, safe, economical operation of the vehicle will be materially affected.

The operating air pressure recommended by the tire manufacturer is as essential to the safe and economical operation of the tire as the proper amount of oil would be to the engine or other chassis units.

An under-inflated tire runs sluggishly, heats up quickly because of the greater flexing, and is subjected to more frequent bruising. On the other hand, over-inflation may weaken the tire causing a blow-out. In addition to the deteriorating effect improperly inflated tires may have on the tire life, this condition will affect steering, riding comfort, and safe driving. FOLLOW THE TIRE PRESSURE RECOMMENDATIONS OF THE TIRE MANUFACTURER. Figure 1 shows sectional views of properly and improperly inflated tires.

BALANCED INFLATION

The whole efficiency of the vehicle will be upset if air pressures in the tires are out of balance. Balanced inflation may be expressed as -- all tires on the same axle should always carry the same pressure. A difference in air pressure of the rear tires and front tires may be permissible within certain limitations; however, there should not be a difference in pressures between the right and left tires on the same axle. A five pound under-inflation in one front tire not only can destroy ease of steering but creates steering hazards which generally point to a potential accident. An under-inflated rear tire can destroy the value of the most efficient brakes. Balance the tires for ease of steering, comfort in riding, safety in driving, as well as for minimum fuel consumption and maxiumum tire mileage.

PRESSURE LOSS

At periodic intervals, each tire should be gauged for pressure loss with an accurate gauge before tires are brought to correct operating pressure. The purpose of this check is to determine exact pressure losses in each tire. In other words, if at the time this check is made, a definite pressure loss is noted in any one of the tires, an inspection should be made of the tire showing the loss and cause of loss corrected. This method should definitely establish a "danger signal" on the condition of the tires. The pressure loss check should be made consistently with the same gauge, so that any element of inaccuracy in the gauge will be the same for all tires.

ROTATION OF TIRES

Tires should be interchanged at regular intervals to obtain maximum life. Change wheels without dismounting tires so direction of rotation will be reversed. The following system of interchanging is suggested: Right front to left rear inside or right rear outside. Left front to right rear inside or left rear outside.

If the inside tires show more wear than the outside dual tires, place front tires on inside when changing. In this case, outside dual tires can be interchanged between right- and left-hand side of vehicle.

If the outside dual tires show more wear than the inside dual tires, place front tires on outside when changing. At the same time, interchange right- and left-hand inside duals.

New tires should be installed on front wheels where they run coolest.

TIRE VALVES

The valve core is a spring loaded check valve in the valve stem, permitting inflation or defaltion of the tube. This check valve, or core, is not intended to hold the air during operation. The valve cap is provided to seal the air in the tube. When valve cap is tightened down on stem the sealing washer inside cap is pressed tightly against top of stem, preventing air leakage. It is important, therefore, that valve caps be used.

TIRE REMOVAL

To remove tire from rim, first remove wheel from hub then proceed as follows:

1. Deflate tire by removing valve core.
2. Insert screw driver between rim and split lock ring. Pry ring over edge of rim.
3. Remove lock ring and side ring as a unit.
4. Remove tire and tube.

TIRE INSTALLATION

1. NOTE: When installing synthetic tubes, coat both sides of the flap, the inner diameter of the tube, and the inside of the tire beads with a solution of neutral vegetable oil soap. Use a brush or cloth swab to apply the solution. Do not allow the solution to run down into the tire. This treatment aids tube in shaping itself during inflation without undue stretching in the rim and bead region.
2. Place tube in casing and inflate just enough to remove wrinkles. Place tire on rim with valve stem in slot in rim.
3. Install side ring and lock ring assembly. Make sure lock ring is fully seated.
4. Inflate tube slowly to about 10 pounds pressure, then again make sure that lock ring is fully seated. Turn wheel and tire assembly so that lock ring is away from person inflating tire, then reach through hole in wheel to apply air hose chuck to valve stem and inflate to correct pressure. Deflate tire by removing valve core, reinstall valve core, and reinflate to correct pressure.

Trouble Shooting

Contents of This Section

The information contained in this section includes a list of trouble symptoms which might be encountered. In addition, probable causes and remedies are briefly listed. No attempt is made in this section to outline detailed repair instructions, as these instructions are included in the various sections of the Maintenance Manual (see Index at front of manual).

The causes of trouble symptoms in any automotive vehicle may be varied; therefore, a hit-and-miss search would result in a tedious guessing contest. A proper diagnosis of symptoms is an orderly process of eliminating the causes of the symptoms. An "orderly process" means to check the most probable or common cause first, then proceed with the next cause.

Additional publications covering units used in these vehicles are as follows:

Unit	Form No.
Diesel Engine	X-4517

When any trouble is encountered in these units always refer to the applicable publication.

The following procedures are grouped to permit a practical diagnosis of trouble symptoms. In many instances, a symptom indicating trouble in one unit may be caused by a difficulty in a closely related unit or system.

ELECTRICAL SYSTEM TROUBLE SHOOTING

This paragraph includes those symptons which may occur in the starting system, battery, generator, regulator and lighting system. In addition to the information given on these pages, also refer to other sections of this manual covering respective units.

Always remember a connection that is clean and tight is a good connection.

STARTER

If the engine fails to start after repeated and satisfactory operations of the starter, cause of failure cannot be attributed to the starting system, but to other functioning systems of the engine.

Starter Fails to Operate

1. Low battery. If the battery is run down, recharge or replace.
2. Loose or broken battery or ground cables. Thoroughly clean terminals and tighten or replace cables as necessary.
3. Starter solenoid contacts corroded or burned, preventing a good contact. Check and clean contacts or replace solenoid.
4. If, after making the above corrections, the starter still fails to operate, it is in need of an overhaul and must be repaired or replaced.

Starter Noisy

1. Loose mounting. Tighten cap screws or stud nuts attaching starter to clutch housing.
2. Insufficient lubrication. Lubricate as directed in Lubrication (Sec. 13 of this manual).
3. If starter is still noisy, it is in need of an overhaul and must be repaired or replaced.

Slow Cranking Speed

1. Heavy engine oil in a cold engine. Refer to Lubrication (Sec. 13 of this manual) for correct viscosity of oil.
2. Weak battery or loose cable connections. Check and correct these conditions.
3. Excessive resistance in circuit. Perform line voltage tests.
4. If the starter still operates slowly after making the above corrections, it is in need of overhaul and must be repaired or replaced.

BATTERY

Discharged

1. Loose or corroded terminals. Remove cables and clean terminals.
2. Low water in cells. Replenish water or replace battery.

TROUBLE SHOOTING

3. Shorted cells. Test and replace battery if necessary.

4. Defective generator. Test and replace if necessary.

5. Improper regulator adjustment. Test, adjust, or replace.

Overheating

Defective or improperly adjusted regulator. Test, adjust, or replace.

GENERATOR AND REGULATOR

Since the generator and regulator functions are directly related, both units must be considered when checking symptoms of failure in the generator circuit. When the ammeter shows an unsatisfactory reading, make sure the ammeter is correct before making any repairs on the generating system.

High Charging Rate With Fully Charged Battery

1. Check generator to regulator ground wire for damage or loose connections.

2. Clean and tighten all terminals and connections in generator circuit.

3. If conditions still exists, either the voltage regulator is in need of adjustment, or the generator is in need of an overhaul. In either case, replace with a new or rebuilt unit.

Low or No Charging Rate With Low Battery

1. Check all wires between generator and regulator for worn insulation or other damage. Clean and tighten all connections.

2. Loose fan belt.

3. If this does not correct the trouble, either the generator or regulator, or both, must be replaced with new or rebuilt units.

Noisy Generator

1. Loose generator mounting. Tighten.

2. If noise is still present, generator is in need of overhaul and must be repaired or replaced with a new or rebuilt unit.

LIGHTING SYSTEM

Reference to wiring diagram will show that a single circuit from battery to gang switches is common to all lights on the vehicle. At gang switches that single circuit is divided into multiple circuits, each of which is common to its particular circuit. These circuits are then taken to junction points where they are divided into individual circuits, each of which is taken to a single light. The return path of each circuit is through ground to battery. Dividing the circuits in this manner provides a convenient and logical method of locating the source of trouble. The use of a voltmeter or trouble lamp, and adherence to the following principles will aid in locating trouble in the lighting system.

1. Source of trouble common to all lights will be located in that part of the circuit common to all lights.

2. Source of trouble common to one or more --but not all--lights will be located in that part of the circuit common only to the lights affected.

3. Source of trouble at a single light will be confined to the individual circuit of the light affected.

One Light Fails

This condition is the result of an open circuit or grounded wire between the light ground and the feed wire junction. Open circuit or grounded wire may be caused by a burned out or broken light bulb filament; poor ground at light; corroded contacts or terminals; broken wire; frayed insulation; grounded or shorted terminals; or defective light switch.

Two or More Lights Fail

The cause of this condition will be located between the light switch and the individual light junction. Cause may be defective individual light switch, loose or corroded terminals, or broken wire. When two or more lights controlled by a single switch fail while others on the same switch are satisfactory, it indicates that the defect is between junction and lights.

All Lights Fail

The cause of this condition will be located between the point where the battery ground strap attaches to the frame and the light switches.

1. Discharged battery, corroded battery terminals, corroded or broken battery cable or ground strap. These points can be checked by cranking engine with starter. If cranking speed is normal, trouble lies between the battery and light switches.

2. Loose or corroded terminals; defective light switches; short circuit or ground at some point in system which causes the fuse to burn out. The only remedy is to methodically check the system until the fault is located and corrected.

3. A vehicle not in use for some time may possibly have all light bulb contacts corroded to the point where lights are inoperative. A remote possibility of failure is that all filaments may have been broken by shock.

Lights Give Insufficient Light

Excessive resistance in circuit or discharged battery. Check condition of battery, then look for loose or corroded terminals and contacts, and frayed insulation on wires.

Frequent Light Bulb Failure

High voltage, caused by a defective or improperly adjusted voltage regulator Adjust or replace.

FRONT END TROUBLE SHOOTING

The symptoms which follow in this paragraph pertain to front wheel action trouble, generally caused by incorrect front wheel alignment, steering geometry, or steering mechanism. Therefore, all trouble symptoms which may relate to the steering of the vehicle are included.

Whenever diagnosing steering difficulties, other allied factors must be checked. A symptom indicating possible trouble in the steering system may also be evidence of deficiency in other units, that is: front axle alignment, front spring suspension, tire inflation, wheel and tire mounting, wheel bearing adjustment, frame alignment, and brakes.

HARD STEERING

1. Improper adjustment of steering gear worm bearing, sector shaft lash, or drag link. Check adjustments and correct.
2. Under-inflated front tires. Inflate to manufacturer's recommendation.
3. Lack of lubrication. Lubricate as directed in Lubrication (Section 13 of this manual).
4. Bent controls in steering gear linkage. Check as directed in Front End Alignment and Steering (Sections 1A and 16 of this manual). Repair or replace defective parts.
5. Bent, broken, or worn front axle parts. Replace damaged parts.
6. Bent body longitudinal member. Check and correct if necessary.
7. Front wheel misalignment. Check as directed in Front End Alignment (Section 1A of this manual).

WANDER OR LACK OF STEERING CONTROL

1. Loose steering gear mounting, pitman arm loose, or excessive sector gear backlash. Check and adjust as necessary.
2. Loose drag link ball sockets. Tighten or replace worn parts.
3. Front wheel or axle misalignment. Check and make necessary corrections.
4. Steering system parts worn. Overhaul and replace defective parts.
5. Unequal tire pressure. Inflate both tires to tire manufacturer's recommendation.
6. Unequal camber. Check and make necessary corrections. Refer to Front End Alignment (Section 1A of this manual) for alignment instructions and data.

ROAD SHOCK TRANSMITTED TO STEERING WHEEL

1. Worn or mal-adjusted wheel bearings. Replace or adjust as necessary.
2. Excessive tire pressure. Inflate to tire manufacturer's recommendation.
3. Improper adjustment of drag link, worm bearings, or sector gear lash. Check adjustments and correct if necessary.

UNEQUAL RIGHT AND LEFT TURNING RADIUS

1. Front axle shifted on springs. Check and correct as necessary. Keep spring clip nuts tight.
2. Improperly adjusted steering knuckle stop screws.

FRONT WHEEL SHIMMY

1. Unequal tire pressure. Inflate tires equally and to tire manufacturer's recommendations.
2. Broken, bent, or worn front axle parts. Replace damaged parts.
3. Broken, bent, or worn steering mechanism parts. Replace damaged parts.
4. Improper toe-in and caster. Check and adjust. Refer to Front End Alignment (Section 1A of this manual).
5. Tire or wheel out of balance. Test and rebalance.
6. Improper steering gear or drag link adjustment. Check and adjust. Refer to Steering Gear (Section 16 of this manual).
7. Bent or improperly mounted tire or wheel.
8. Improperly adjusted or worn bearings. Adjust or replace.

VEHICLE PULLS TO ONE SIDE

1. Incorrect toe-in. Check and adjust.
2. Incorrect camber and caster. Check, adjust, or replace defective parts.
3. Defective springs. Refer to "Spring Trouble Shooting" later in this section.
4. Broken, bent, or worn front axle parts. Replace damaged parts. Refer to Front End

TROUBLE SHOOTING

Alignment and Front Axle (Sections 1A and 1B of this manual).

5. Improper alignment or broken body longitudinal member. Check and correct if necessary.

6. Incorrect axle alignment. Check and tighten spring clips and center bolt. Refer to Front End Alignment and Springs (Sections 1A and 15 of this manual).

7. Unequal tire pressure. Inflate both tires evenly and to tire manufacturer's recommendation.

8. Worn or improperly adjusted wheel bearings. Adjust or replace.

9. Front brake dragging on one side. Adjust brakes evenly or replace defective parts.

REAR AXLE TROUBLE SHOOTING

An unusual noise is usually the first indication of improper functioning of axle driving parts. Noises which seem to come from the axle may be caused by some other unit such as transmission, propeller shaft, or tires.

CONTINUOUS AXLE NOISE

1. Difficulty in the axle or unevenly worn tires.

2. To determine if noise is caused by axle or by tires, drive vehicle on soft terrain. If this stops the noise, it is being caused by the tires and not by the axle. Inflate tires to manufacturer's recommended pressure or replace if necessary.

3. If noise continues on soft terrain, it is caused by worn or improperly adjusted wheel bearings, differential gears or bearings, or by insufficient lubricant in the differential. Add lubricant, adjust wheel bearings, adjust, repair, or replace axle differential assembly.

AXLE NOISE ON DRIVE OR ON COAST ONLY

1. Differential pinion and ring gear out of adjustment or worn excessively. Adjust, repair, or replace axle differential assembly.

EXCESSIVE BACKLASH IN AXLE DRIVING PARTS

1. Loose axle shaft or drive flange cap screws or stud nuts, worn holes in flanges, or worn splines on axle shafts. Tighten cap screws or stud nuts, or replace axle shafts if necessary.

2. Differential pinion and ring gear out of adjustment or worn excessively. Adjust, repair, or replace axle differential assembly.

BRAKE TROUBLE SHOOTING

SLOW BRAKE APPLICATION

1. Low brake line pressure. Check and adjust application valve graduated pressure range.

2. Broken brake chamber diaphragm or leaking chamber. Tighten chamber flange bolts or replace diaphragm.

3. Restriction in brake lines. Remove and clean or replace.

4. Excessive chamber push-rod travel. Adjust.

5. Worn brake shoe linings. Install new linings and recondition or install new brake drums.

6. Quick release valve corroded. Remove and clean or replace.

SLOW BRAKE RELEASE

1. Quick release, or application valve corroded. Remove and clean or replace.

2. Restriction in lines preventing quick release of air pressure. Remove lines and clean or replace.

3. Intake valve in brake application valve not seating properly. Disassemble, inspect, clean, and replace defective parts.

4. Brake camshaft binding. Remove and clean.

5. Brake shoe rollers sticking or shoe frozen at anchor pin. Clean up and lubricate.

6. Lack of Lubrication. Lubricate slack adjusters, shoe rollers, camshaft supports, cam face, and shoe anchor pins as directed in Lubrication (Section 13 of this manual).

LOW AIR PRESSURE

1. Leak in air lines or fittings. Check all lines and connections with soap suds. Replace defective parts or tighten connections.

2. Leak at application valve intake valve. Remove valve and disassemble, inspect, repair, or replace defective parts.

3. Governor defective or improperly adjusted. Test and adjust, repair, or replace governor as directed in Air Compressor and Governor (Sec. 4C of this manual).

4. Defective compressor unloading valve operation. Check clearance between valve stems and adjusting screws. Remove compressor cylinder head and clean valves and stems. Regrind or replace valves if necessary. Check tension

of valve springs. Refer to Air Compressor and Governor (Sec. 4C of this manual).

5. Defective compressor discharge valve operation. Clean, inspect, and regrind or replace valve discs and seats if necessary. Check tension of valve springs. Refer to Air Compressor and Governor (Sec. 4C of this manual).

6. Compressor discharge line choked with carbon. Remove and clean.

SLOW PRESSURE BUILD UP

1. Check all items previously listed under "Low Air Pressure."

2. Worn compressor parts necessitating complete overhaul of compressor. Refer to Air Compressor and Governor (Sec. 4C of this manual).

RAPID LOSS OF PRESSURE WHEN ENGINE IS STOPPED

1. Air leaks in system. Check all air line connections for leakage, using soap suds. Also check for leakage at application, and quick release valve exhaust ports. Make necessary repairs or replacements.

2. Defective compressor discharge valve operation. Clean, grind, or replace discharge valve discs and seats.

EXCESSIVE AIR PRESSURE

1. Defective unloading diaphragm. Replace diaphragm.

2. Excessive clearance between unloading valve stems and adjusting screws. Adjust as directed in Air Compressor and Governor (Sec. 4C of this manual).

3. Governor improperly adjusted or defective. Adjust, repair, or replace governor as directed in Air Compressor and Governor (Sec. 4C of this manual).

4. Restricted unloading chamber to governor air line. Remove line and clean out or replace.

NOISY BRAKES

1. Dirty, worn, or loose brake linings, or distorted brake shoes. Inspect and replace damaged or worn parts.

2. Scored or damaged brake drums. Inspect, repair, or replace as directed in Air Brakes (Sec. 4B of this manual).

ONE BRAKE DRAGS

1. Improper adjustment. Adjust.

2. Corroded or bent brake mechanism. Weak or broken brake shoe return spring. Clean, inspect, and replace defective parts.

3. Restricted brake line. Remove, inspect, and correct as necessary.

4. Inoperative chamber due to bent push rod. Replace damaged parts.

5. Wheel bearings out of adjustment. Adjust.

CLUTCH TROUBLE SHOOTING

The clutch is designed for maximum efficiency and long life, and with reasonable care, no operating difficulty should be encountered. Natural wear will occur, however, and must be compensated for by adjusting when required.

CLUTCH SLIPPING

1. Improper adjustment (no pedal free-travel). Adjust pedal free-travel.

2. Worn facings, grease on facings, clutch disc hub binding on clutch shaft, or insufficient spring tension. Replace defective parts or complete clutch assembly.

3. Pressure plate sticking. Excessive clearance between driving block and pressure plate lugs. Refer to Clutch (Sec. 5 of this manual) for correction and clearances.

CLUTCH GRABBING AND CHATTERING

1. Improper operation. Correct poor driving practices.

2. Improper adjustment. Adjust pedal free-travel. Refer to Clutch (Sec. 5 of this manual).

3. Loose engine mounting bolts. Inspect and tighten if necessary.

4. Grease on facings, worn splines on clutch shaft or in disc hub, facing loose on disc, or pressure plate scored or rough. Replace defective parts or complete clutch assembly. Inspect for worn splines on clutch shaft and replace if this condition is found.

IMPROPER RELEASE

1. Improper adjustment. Adjust.

2. Pressure plate or driven disc worn, warped, or distorted. Inspect, repair, or replace defective parts.

3. Weak or broken return springs. Replace.

4. Worn release bearing. Install new bearing and adjust pedal free travel.

5. Controls binding. Inspect and correct cause.

TROUBLE SHOOTING

SPRINGS TROUBLE SHOOTING

HARD RIDING

1. Overloaded or load unevenly distributed. Always distribute load evenly and do not overload.
2. Shackle pins and bracket bolts "frozen" or broken due to insufficient lubrication. Lubricate as specified in Lubrication (Sec. 13 of this manual). Remove and clean or replace defective shackle pins or bracket bolts.
3. Axle shifted due to loose spring clips. Relocate and tighten spring clip nuts.

OVER FLEXIBLE

1. Excessive lubrication of spring leaves. Lubricate only at intervals specified on Lubrication Chart.
2. Broken spring leaf rebound clips. Replace broken parts.
3. Shock absorbers not functioning. Lack of fluid, worn or broken parts. Keep filled to level plug or disassemble and inspect for parts failure.

EXCESSIVE NOISE

1. Worn shackle bolts and spring eye bolts or bushings. Check and replace worn parts.
2. Loose spring clip nuts. Relocate axle if shifted and tighten spring clip nuts.

SPRING LEAF FAILURE

1. Overloading vehicle or driving at excessive speed over rough terrain. Reduce speed and do not overload.
2. Loose rebound clips. Keep clips tight.
3. Frozen shackle pins and bracket pins due to lack of lubrication. Remove shackle and bracket pins and clean or replace as necessary. Lubricate as directed in Lubrication (Sec. 13 of this manual).
4. Grabbing brake. Refer to "Brake Trouble Shooting" previously described in this section for causes and remedies.

TRANSMISSION TROUBLE SHOOTING

Symptoms indicating trouble in transmission is sometimes caused by another assembly, such as axle, propeller shaft, universal joint, or clutch. Therefore, before removing the transmission to locate the trouble, always check the possibility that trouble may exist in other units.

NOISY

Before beginning actual operations to eliminate noise attributed to transmission, make sure that the noise is not coming from another unit in vehicle, such as propeller shafts or rear axle. Also bear in mind that a limited amount of transmission gear "noise" is normal, except when the unit is in direct drive. Following are some of the causes of noise with suggested remedies.

1. Worn or damaged parts. Replace parts as necessary or overhaul the assembly.
2. Improper or insufficient lubricant. Change or add lubricant as directed in Lubrication (Sec. 13 of this manual).
3. Misalignment of transmission with clutch housing. Tighten transmission mounting bolts if not tight, otherwise determine and correct cause of misalignment.

SHIFTING DIFFICULTIES

1. Clutch release linkage improperly adjusted. Adjust or repair clutch release mechanism as directed in Clutch (Sec. 5 of this manual).
2. Binding in transmission control cover. Remove and inspect control mechanism for bent or worn parts. Replace damaged parts.
3. Bent or binding of control rods at guides. Check and make necessary corrections.
4. Incorrect driving practices. Coordinate the use of gearshift lever with use of clutch and accelerator. Refer to Operation (Sec. O of this manual).
5. Too heavy gear lubricant. Refer to "Lubrication Chart" for recommended type of lubricant and viscosity.
6. Reverse solenoid linkage out of adjustment will contribute to difficulty when shifting into reverse. Adjust linkage as directed in Mechanical Transmission (Sec. 17 of this manual).

JUMPING OUT OF GEAR

1. Improper shifting. Completely engage mating gears before releasing clutch. Move gearshift lever until poppet engages notch in shift rod.
2. Excessive end play due to wear in one or more of following parts: Shift forks, fork grooves in sliding clutches, thrust washers, mainshaft or countershaft bearings, gear bearings or bushings. Replace worn parts.
3. Broken snap rings permitting gears or shafts to move endwise. Install new snap rings and shims (if required).
4. Shift forks bent or loose on shift rods. Check shift forks for bends and correct offset. Tighten fork retaining screw.
5. Loose propeller shaft companion flange nut. Tighten nut.
6. Poppet springs weak or broken. Replace.

LUBRICANT LEAKS

1. Lubricant level too high. Keep level at filler plug level. Refer to Lubrication (Sec. 13 of this manual).
2. Worn oil seal. Replace oil seal assembly.
3. Main drive gear bearing retaining screws loose. Tighten screws.
4. Cover plate screws loose or gaskets defective. Tighten screws or replace gaskets.
5. Bearing retainers (caps) loose. Tighten screws firmly.
6. Transmission case cracked or broken. Replace transmission case. No repair is recommended.

PROPELLER SHAFT TROUBLE SHOOTING

EXCESSIVE NOISE OR VIBRATION

1. Lack of lubrication. Lubricate as directed in Lubrication (Sec. 13 of this manual).
2. If propeller shafts are not assembled with universal joints in the same plane, vibration will result. Check for this condition and if found, disconnect propeller shafts and place universal joints in same plane.
3. Worn universal joint bearings or journals, or a sprung propeller shaft will cause vibration and noise. Check for these conditions and replace propeller shaft assembly if necessary.
4. Any mechanical movement has vibration periods, which do not result in noise until they tune in with some other part or unit. In this connection, loose or broken body panels, etc., should be checked as the source of noise if the above remedies do not correct the condition.

WHEELS, HUBS, AND TIRES TROUBLE SHOOTING

When localizing wheel and tire trouble symptoms, consideration must also be taken of various related systems such as brakes, wheel alignment, and steering gear system. Deficiencies in these systems or units will affect performance of wheels, tires, and hub bearings.

EXCESSIVE OR UNEVEN TIRE WEAR

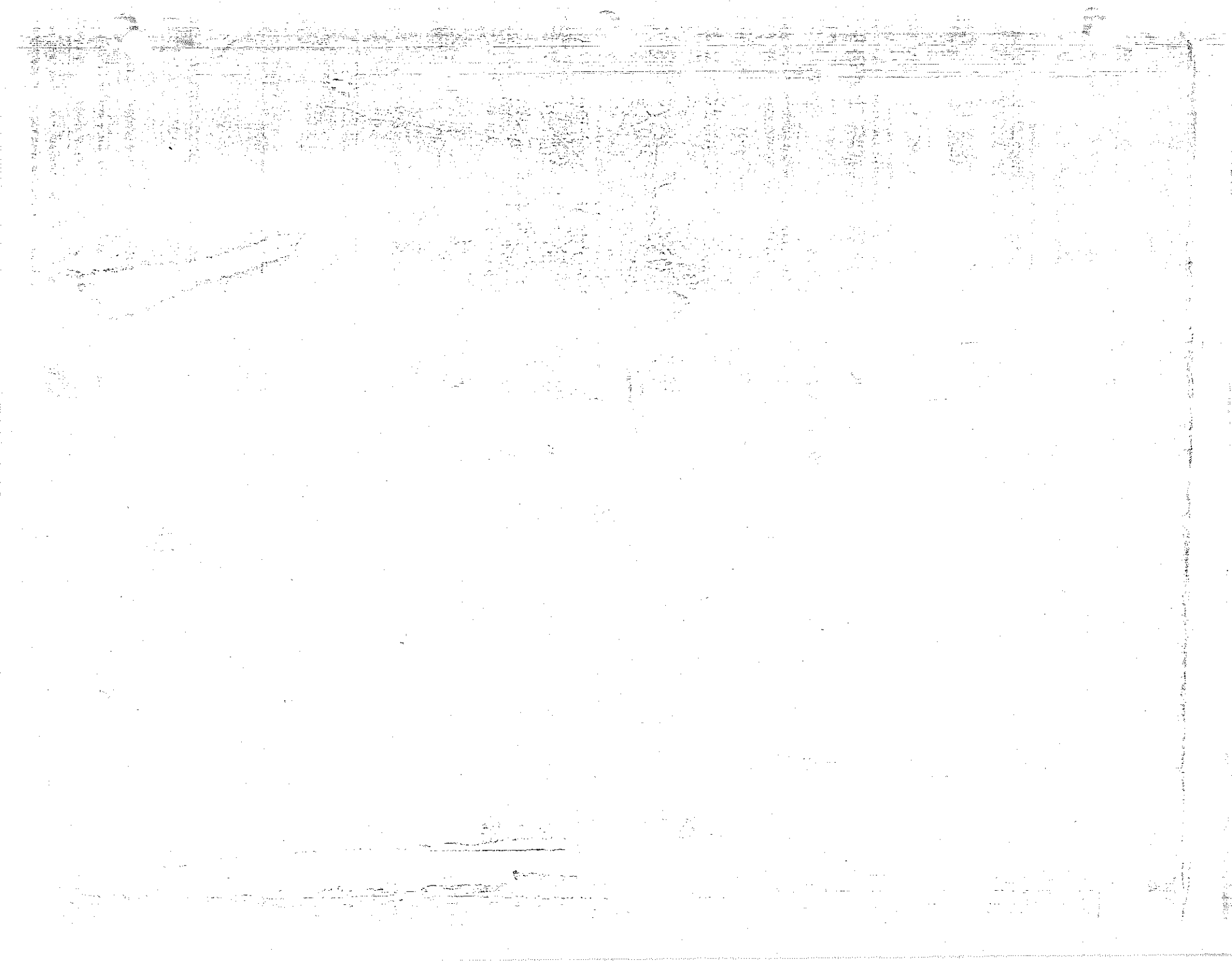
1. Unequal pressures in the tires. Inflate all tires to tire manufacturer's recommendations.
2. Front wheel misalignment. Check front wheel alignment and make necessary corrections.
3. Bent wheels or damaged wheel bearings. Replace wheels or bearings as necessary.
4. Broken, bent, or worn front axle parts. Replace damaged parts. Refer to Front End Alignment and Front Axle (Sec. 1A and 1B of this manual).
5. Improper steering geometry. Refer to Front End Alignment (Sec. 1A of this manual).

WHEELS POUNDING

Hub bearings damaged or in need of adjustment. A bent wheel will also cause this condition. Replace or adjust hub bearings, or replace wheel.

SHIMMY

Conditions causing wheel shimmy are previously listed under "Front End" in this section.




GM
GENERAL MOTORS
COACH

Form X-4714

AIR CONDITIONING

★ ★

used on Model PDA-3703

★ ★ ★

GENERAL MOTORS CORPORATION
GMC TRUCK & COACH DIVISION
PONTIAC, MICHIGAN

In This Manual

TECHNICAL PUBLICATIONS 1M-7-47

Foreword

AIR CONDITIONING

This manual covers operation, care and maintenance of the Air Conditioning unit and controls used on some Model PDA-3703 coaches.

Heating and ventilation systems used on coaches without air conditioning units and such systems used in conjunction with the air conditioning units are explained in the Maintenance Manual, Form X-4710, covering PDA-3703 coaches.

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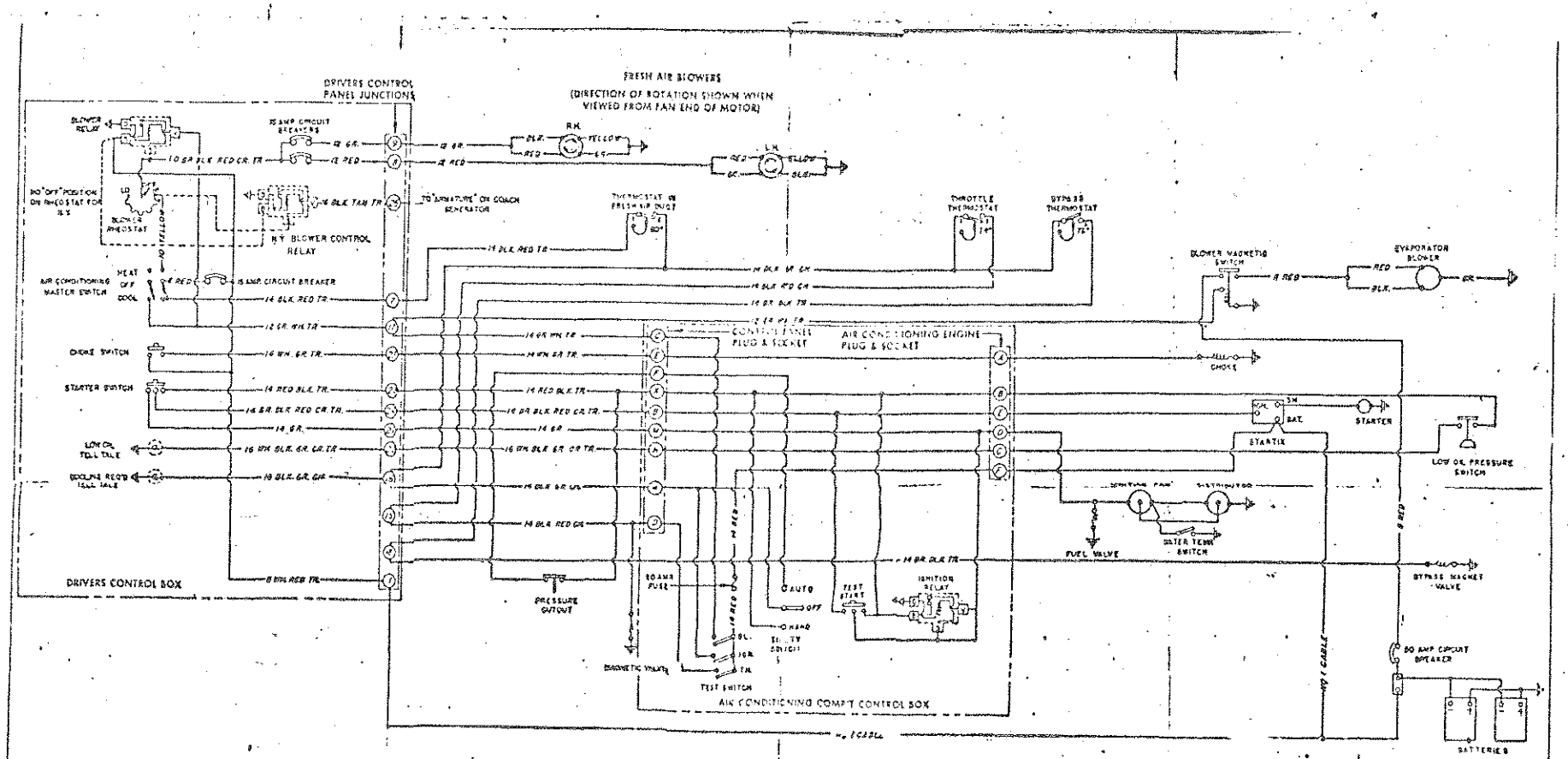
Alphabetical Index



Unit Name	Location
Driver's Control Box	Left of Driver
Blower Rheostat Switch	On Driver's Control Box
Air Conditioning Master Switch	On Driver's Control Box
Choke Switch	On Driver's Control Box
Starter Switch	On Driver's Control Box
Low Oil Tell Tale Light (red)	On Driver's Control Box
Cooling Req'd. Tell Tale Light (green)	On Driver's Control Box
Blower Relay	In Driver's Control Box
N.Y. Blower Control Relay	In Driver's Control Box
Circuit Breakers (three 15 amp.)	In Driver's Control Box
Driver's Control Panel Junctions	Behind Driver's Control Box

Unit Name	Location
Air Conditioning Comp't Control Box	In Top Front Corner of Air Conditioning Unit Compartment
Control Panel Plug and Socket	In Air Cond. Comp't. Control Box
Engine Plug and Socket	In Air Cond. Comp't. Control Box
Ignition Relay	In Air Cond. Comp't. Control Box
Test Switch	On Air Cond. Comp't. Control Box
Safety Switch	On Air Cond. Comp't. Control Box
Test Start Switch	On Air Cond. Comp't. Control Box
Fuse (80 amp.)	In Air Cond. Comp't. Control Box
High-Low Pressure Cut-Out Switch	On Front Bulkhead in Engine Compartment
Throttle Control Magnet Valve	On Front Bulkhead in Engine Compartment
Fuel Solenoid Shut-off Valve	Behind Engine Air Cleaner

Unit Name	Location
Water Temperature Switch	On Engine Cylinder Head
Starter	On Top Front of Engine
Low Oil Pressure Switch	On Top Front of Engine
Circuit Breaker-Evaporator Blower Circuit (50 amp.)	In Diesel Engine Left-hand Compartment
Electric Choke	On Engine
Bypass Shutter Magnet Valve	In Diesel Engine Right-hand Compartment
Evaporator Blower	In Roof at Rear End of Vehicle
Evaporator Blower Magnetic Switch	In Evaporator Compartment
Engine Ventilation Thermostat	In Evaporator Compartment
Bypass Shutter Thermostat	In Evaporator Compartment
Fresh Air Thermostat	In Duct Behind Left-hand Fresh Air Blower
Fresh Air Blowers	At Front End of Each Package Rack

Air Conditioning Wiring Diagram
GM Coach Model PDA 3783

X-4734-A - 5M - 11-48

System Operation

In This Section

GENERAL DESCRIPTION

The GM Coach Air Conditioning System is designed to provide passenger comfort by cooling, dehumidifying, and filtering the air which is force-circulated within the coach. Briefly, the air conditioning system comprises the following units or systems:

1. The condensing unit, consisting of a four-cylinder gasoline engine and accessories; a rotary, two-stage, multi-vane type refrigerant compressor; a fin and tube condenser; and a liquid refrigerant receiver. This unit, which is assembled as a package unit assembly, is mounted in left side of coach at rear of left front wheel.

2. The cooling unit, consisting of a fin and tube type evaporator coil and a multi-outlet thermo type expansion valve. These units are mounted in roof of coach at rear of vehicle, and are accessible through a door in ceiling which also carries the recirculated air filters.

3. The air circulating system, comprising fresh air intake blowers and ducts, evaporator blowers and cooled air distribution ducts, air filters, and air exhaust ventilators. Fresh air blowers are mounted in roof at forward end of each package rack. Evaporator blowers are mounted in roof at rear of vehicle immediately ahead of evaporator coil. The air ducts are built into the coach body above the side windows and package racks.

4. Air conditioning controls, including driver's control panel, unit compartment control panel, thermostats, and miscellaneous controls which will be described later.

REFRIGERANT

The refrigerant used is commonly known by its trade name of Freon-12 or F-12. The chemical name is dichlorodifluoromethane.

REFRIGERANT CHARACTERISTICS

Freon exists as a gas at atmospheric pressure and must be held under pressure to remain liquid. At ordinary temperatures, it will exist as a liquid under a pressure of about 75 pounds per square inch.

Freon has very little odor, but in large concentrations a faint ethereal sweet odor may be detected. It is colorless in both its liquid and gaseous states.

Freon is nonpoisonous, noninflammable, and nonexplosive. It is noncorrosive to any of the ordinary metals.

TREATMENT IN CASE OF INJURY

Should liquid Freon come in contact with the skin, injury should be treated the same as if skin were frost bitten or frozen. Should liquid Freon get into the eyes, a good eye specialist should be consulted at once. Avoid rubbing or irritating eyes. Give the following first aid treatment as soon as possible.

1. Drops of sterile mineral oil (obtainable at any drug store) should be introduced into eyes. The mineral oil will absorb the Freon.

2. Eye should then be washed, if irritation continues at all, with one of the following:

a. A weak boric acid solution.

b. A sterile salt solution not to exceed 2% sodium chloride (table salt).

3. If irritation continues for a period longer than 12 hours, eye should be treated for secondary infection with 10% Argyrol solution or with 1% Mercuric Oxide ointment.

AIR CIRCULATION

FRESH AIR

Two motor driven fresh air intake blowers (fig. 1) mounted in roof at forward end of each package rack draw in fresh outside air and force it through fresh air ducts into the evaporator compartment at the rear of the vehicle. A filter at each end of evaporator compartment filters the air as it passes into the compartment. These blowers operate automatically whenever the master switch is in "Cooling" position.

COOLED (CONDITIONED) AIR

The evaporator blowers at the rear of the vehicle, which also operate automatically when master switch is in "Cooling" position, draw warm fresh air and recirculated air through the evaporator coil and force it into the cooled air ducts.

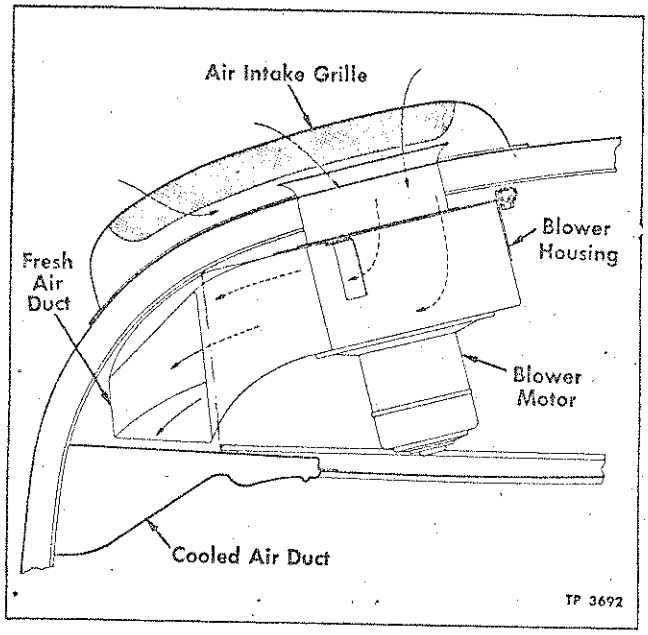


Figure 1—Fresh Air Intake Blower and Motor

As the warm air comes in contact with the cold evaporator coils, moisture in the air is condensed and the air is cooled. Drain pan mounted under evaporator has a drain pipe at each end which carries the condensation away and discharges it under the vehicle.

Due to the velocity of the air passing through the evaporator, a certain amount of condensed moisture is suspended in the air as it leaves the evaporator. The air diffuser, mounted between the evaporator and the blowers, consists of a series of baffles through which the air must pass. Condensed moisture carried by the air collects on these baffles and drains down into the evaporator drain pan.

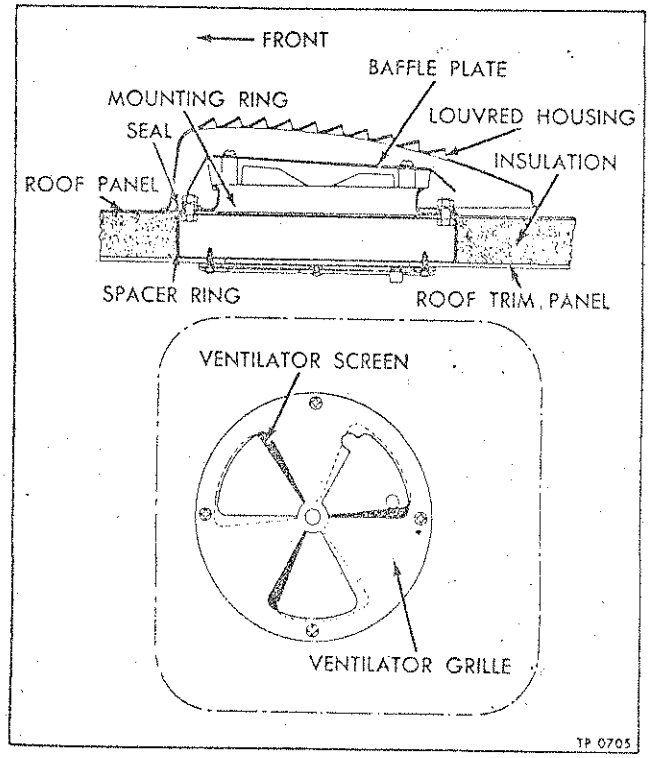


Figure 2—Sectional View of Roof Exhaust Ventilator

Dehumified, cooled air passes through holes in bottom of ducts and is distributed into coach through openings above windows. This permits even distribution of cooled air to all passengers without drafts.

When inside coach temperature is lowered to the desired degree, air bypass shutters, between evaporator and blowers, are closed by means of thermostat control. This causes some of the air being circulated in the coach to bypass the evaporator to prevent lowering the temperature below the desired degree.

RECIRCULATED AIR

A certain portion of the cooled air passes out through the roof exhaust ventilators (fig. 2), and the balance is recirculated through the evaporator and cooled air ducts. Three filters in evaporator compartment door in ceiling filter the air as it is drawn into the evaporator compartment.

The fresh air intake openings being larger than the exhaust ventilator openings, a slight but positive pressure is maintained within the coach.

REFRIGERANT CIRCULATION

A complete cycle (fig. 3) of the refrigerating system is as follows:

1. Liquid refrigerant is forced by its own pressure from the liquid receiver through the refrigerant dehydrator-strainer and expansion valve into the evaporator.

2. In the evaporator the liquid refrigerant evaporates (changes) into its gaseous state. Heat required to cause liquid to evaporate is absorbed from the air passing through the evaporator, thus the air is cooled.

3. Flow of liquid refrigerant into the evaporator is regulated by the expansion valve. The expansion valve is actually a pressure reducing valve which serves two purposes. 1 - It maintains pressure on the liquid line. 2 - It admits only the required amount of liquid refrigerant into the evaporator, this requirement being determined by the temperature of the gaseous refrigerant in the suction line.

4. The refrigerant gas is drawn from the evaporator through the suction line to the compressor.

5. Refrigerant in its gaseous state is drawn into compressor where it is compressed and discharged into the top of the condenser.

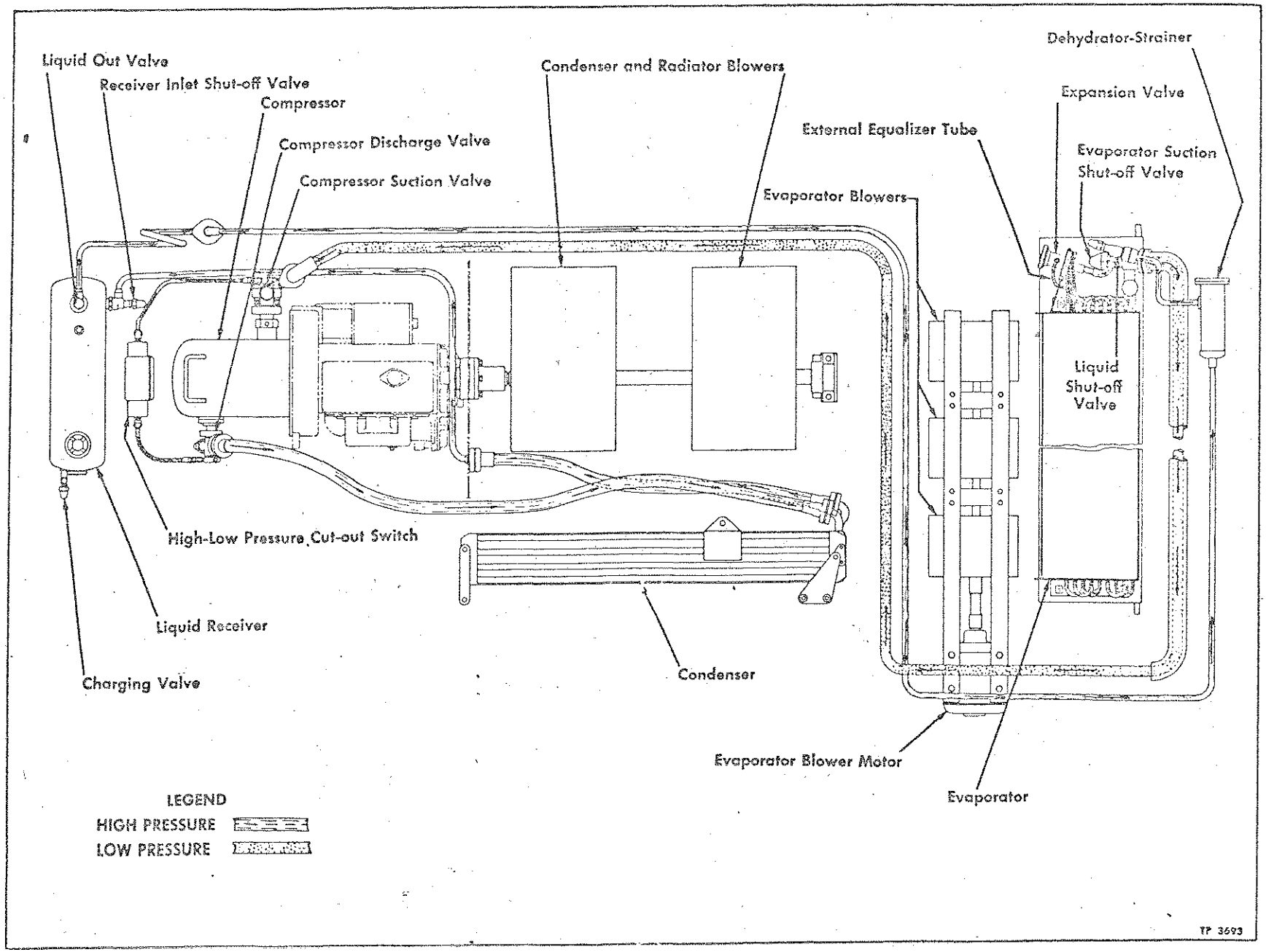


Figure 3—Refrigerant Controls and Lines Showing High and Low Pressures

6. As the heated gas circulates through the condenser, it is cooled by fresh air being drawn through the condenser by two blowers driven directly from the front end of the engine crankshaft. The combined effects of the decreased temperature and increasing pressure cause the gas to condense liquefy.

7. The condensed liquid refrigerant is then forced from the bottom of the condenser into the liquid receiver, and the cycle is repeated.

OPERATION OF SYSTEM CONTROLS

When master switch on driver's control box is placed in "Cooling" position, two separate circuits are energized - the blower circuit and the engine control circuit. Following is a list of the various controls with a brief description of their function in the system. Detailed description of operation of each unit will be found in "Maintenance" section later in this manual. Refer to Wiring Diagram (fig. 4) for wiring connections and circuits.

CIRCUIT BREAKERS

Three 15 amp. automatic reset type circuit breakers are mounted in driver's control box. One of these circuit breakers protects the master switch, and the other two protect the right- and left-hand fresh air blower motors from overload.

One 50 amp. automatic reset type circuit breaker, mounted on bulkhead in left-hand side of Diesel engine compartment, protects the evaporator blower motor from overload.

FRESH AIR DUCT THERMOSTAT

Thermostat mounted in fresh air duct behind left-hand fresh air intake blower controls the engine control circuit. This thermostat is open below 60°F. and closed above 65°F. Thus, when temperature of outside air is below 60°F., the thermostat opens, interrupting the engine control circuit and the air conditioning unit cannot be started.

With outside temperature above 65°F., thermostat is closed, the engine control circuit is energized, and the air conditioning unit may be started if desired. Green (Cooling Required) telltale on driver's control box remains illuminated at all times when the fresh air thermostat is closed and the master switch is in "Cooling" position.

FRESH AIR BLOWER RELAY

Blower relay, mounted in driver's control box, is energized with master switch in "Cooling" position. Relay feeds circuit to fresh air blower motors direct from the No. 1 terminal on junction panel behind driver's control box. The fresh air blowers are automatically brought into operation whenever the master switch is placed in "Cooling" position. Blower rheostat switch has no control over blowers with master switch in "Cooling" position; switch is effective only when operating in conjunction with the heating system. When blower control relay is used, blowers operate with generator regardless of switch position. On this installation blower speed can be regulated with rheostat but not turned off.

EVAPORATOR BLOWER MAGNETIC SWITCH

Evaporator blower magnetic switch, mounted beside thermostats in evaporator compartment, is energized with master switch in "Cooling" position. Magnetic switch feeds current direct from battery cable junction to evaporator blower motor. Evaporator blowers are automatically brought into operation when master switch is placed in "Cooling" position.

IGNITION RELAY

The ignition relay, mounted in air conditioning compartment control box, becomes energized when either the driver's start button or the test start button is pressed. This relay controls circuit to engine coil and distributor, engine water alarmstat, and the electric fuel valve.

EVAPORATOR COMPARTMENT THERMOSTATS

Two thermostats mounted in evaporator compartment in roof are subjected to inside coach temperature by the recirculated air which is drawn up through the filters directly below the thermostats. One controls the air conditioning engine speed and the other controls the air bypass shutters.

Bypass Shutter Thermostat

This thermostat, operating a pressure type magnet valve, controls the position of the bypass shutters located between the evaporator and the evaporator blowers. Thermostat is set to close below 72°F. When inside temperature is reduced to just below 72°F., which is the desired temperature, the thermostat closes and energizes the bypass magnet valve, located on bulkhead in right-hand side of Diesel engine compartment. Magnet valve admits air pressure into the shutter control cylinder, closing the bypass shutters. This causes the major portion of the air being drawn from the evaporator compartment to bypass the evaporator. This prevents lowering the inside temperature below the desired degree. When inside temperature rises above the closing point, thermostat opens, magnet valve is de-energized, exhausting air pressure from shutter control cylinder, and the bypass shutters open, permitting full flow of air through the evaporator.

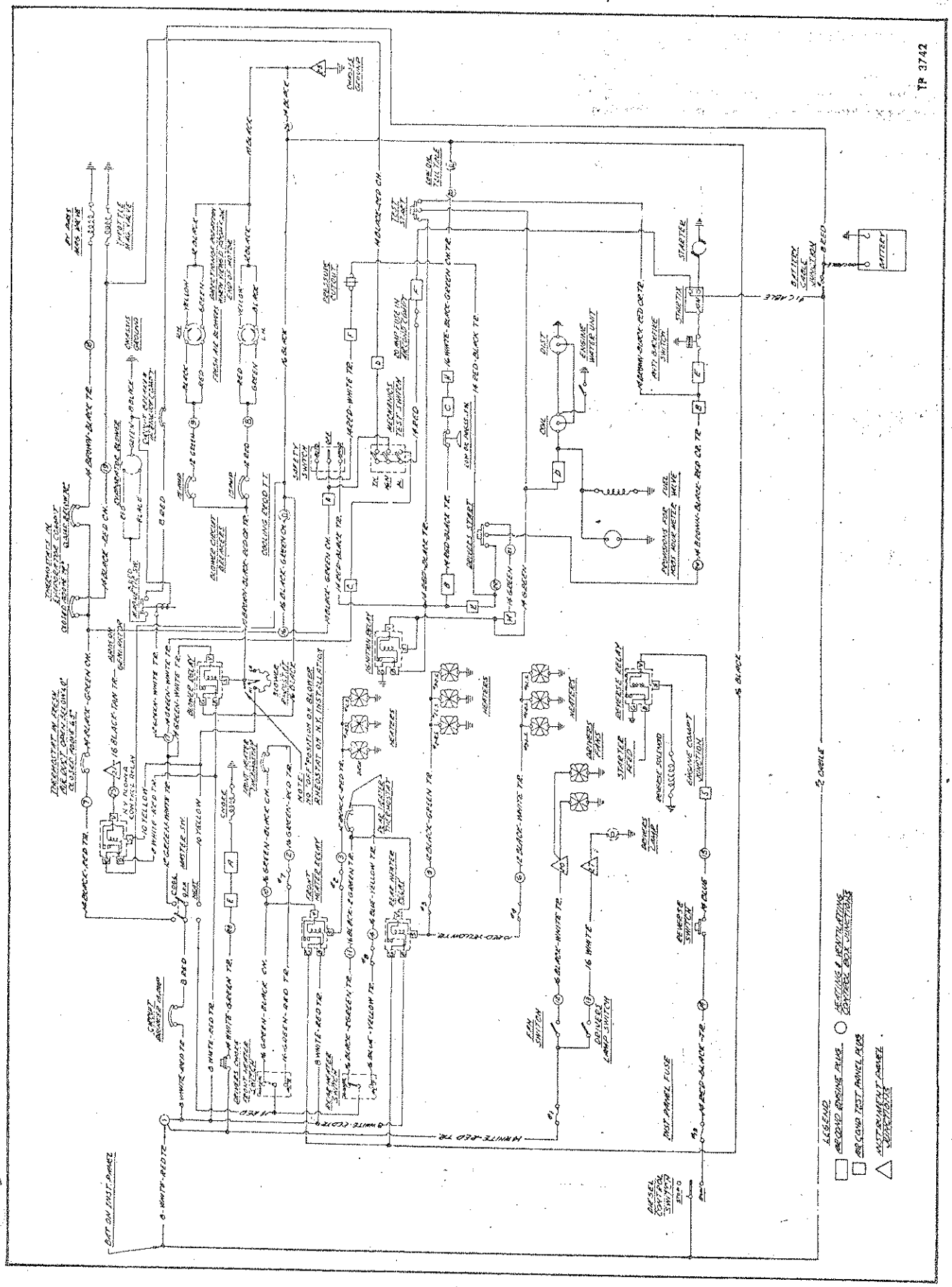


Figure 4—Wiring Diagram

Engine Modulation Thermostat

Since the air conditioning engine runs constantly when air conditioning system is in operation, engine speed is dependent upon cooling requirements. This control is accomplished through the engine modulation thermostat, exhaust type throttle control magnet valve, and throttle control cylinder.

Engine modulation thermostat is set to close above 74°F. When inside temperature reaches 74°F. or higher, considerable load is placed on the cooling system. With thermostat closed, throttle control magnet valve is energized, air pressure is exhausted from the throttle control cylinder, and engine throttle is automatically moved into high speed position (2400 rpm).

When inside temperature is reduced below the closing point, load on cooling system is reduced sufficiently to permit lower engine speed. With thermostat open, magnet valve is de-energized, air pressure is admitted into the throttle control cylinder, and engine throttle is automatically moved into low speed position (1400 rpm).

HIGH-LOW PRESSURE CUT-OUT SWITCH

Definite high and low refrigerant pressures are established at which the system will operate efficiently and safely. High-low pressure cut-out switch is provided to prevent operation of system when pressures exceed these limits. Switch is mounted on air conditioning compartment bulkhead above compressor and is connected to high and low refrigerant pressures at the compressor discharge and suction valves. Current from master switch to ignition relay is routed through the cut-out switch. Whenever the high or low refrigerant pressure exceeds limits, switch interrupts circuit to ignition relay and engine stops. When refrigerant pressures normalize to the pressure switch cut-in point, circuit to ignition relay is again completed and the engine may be started.

LOW OIL PRESSURE SWITCH

Low oil pressure switch connected to engine main oil gallery, controls circuit from master switch to "LOW OIL" tell-tale light on driver's control box. Switch is normally closed, being opened only when engine oil pressure reaches approximately 4 pounds; thus, the low oil tell-tale is illuminated whenever the master switch is in "Cooling" position and the engine is stopped, or the oil pressure is below 4 pounds with the engine running.

ENGINE OVERHEAT ALARMSTAT

Engine overheat alarmstat is installed in engine cylinder head and electrically connected to the engine ignition coil. This unit is provided to prevent operating engine when water temperature reaches a dangerous degree. When water becomes overheated (212°F.), contact points within the alarmstat close, grounding the engine ignition coil and stopping engine.

STARTIX

Startix is used as a magnetic switch in the starting circuit. When driver's start or test start button is pressed, a coil within the startix is energized which closes the main switch contacts, permitting current to flow direct from battery to starting motor. When engine starts, removing load from starting motor, main switch contacts are automatically opened, even though the starter button is still engaged.

ANTIBACKFIRE SWITCH

Antibackfire switch is an automatic circuit controller, installed in engine intake manifold and connected in circuit from start buttons to startix. This switch, actuated by pressure in manifold when engine is turning backward, prevents engagement of starter during backward rotation of engine due to backfire or compression backrock by grounding the circuit from the start button.

FUEL SOLENOID SHUT-OFF VALVE

Fuel solenoid shut-off valve, connected in fuel pump inlet line, is mounted on package unit frame crossmember behind air cleaner. Valve solenoid, connected into engine ignition circuit, is energized (open) whenever engine is running, and de-energized (closed) when engine is stopped. Purpose of valve is to prevent fuel leakage through fuel pump and carbureter due to jiggling of carbureter float when operating vehicle with air conditioning engine not running.

ELECTRIC CHOKE

Electric choke provides driver with means of choking engine during cranking. When driver presses "Choke" button on driver's control box, solenoid in electric choke is energized, Choke lever connected to solenoid plunger is attached to choke butterfly in carbureter by an adjustable link.

SAFETY SWITCH

Safety switch is a three position switch in control box in air conditioning unit compartment. Switch will remain in automatic (Auto) and "Off" positions, but must be held in "Hand" position. "Hand" position is used only for test purposes, and should be used only by experienced personnel. Main purpose of switch is to provide means for mechanic to prevent starting of unit from front while working on unit. Engine cannot be started with safety switch in "Off" position. Switch must be in "Auto" position when operating unit either from driver's seat or at unit compartment. Mech-

anic should always leave switch in "Auto" position after completing service operations.

MECHANIC'S TEST SWITCH

Test switch, mounted in control box in air conditioning unit compartment, is actuated by a push-pull type handle. Switch serves same purpose as driver's master switch, providing mechanic with means of operating system from unit compartment with driver's master switch in "Off" position. Handle is pulled out for "On" position. Bracket on compartment door pushes handle in to "Off" position when door is closed.

FUSES.

The following tabulation lists the location, number, size, and identification of fuses. Refer to wiring diagram (fig. 4) for electrical circuits.

Location	No	Size (Amps.)	Identification
Driver's Control Box	1	20	Driver's Fan & Light
	2,3,4	20	Heaters
	5,6	9	Spares
	7,8	9	Heaters - Automatic
Air Cond. Compt. Control Box	1	20	Startix Circuit
	2,3	20	Spares

LOCATION OF UNITS

The following list covers all the major units in the air conditioning plant together with their relative locations in the vehicle.

This list is in alphabetical sequence for ready reference.

Air Cleaner, Engine	In air conditioning unit comp't.
Antibackfire Switch	On engine.
Blower, Condenser	In back of condenser.
Blowers, Evaporator	In roof at rear of vehicle.
Blowers, Fresh air	At front end of each package rack.
Breather, Crankcase	On engine.
Bypass Shutters	In roof at rear of vehicle.
Check and Drain Valve	On engine air intake pipe.
Circuit Breakers (15 amp.)	In driver's control box.
Circuit Breaker (50 amp.)	In Diesel engine left-hand comp't.
Clutch, Blower Drive	Between engine and condenser blowers.
Compressor	On engine.
Condenser	In air conditioning unit compartment.
Control Cylinder Bypass Shutter	In roof at rear of vehicle.
Control Cylinder, Throttle	On engine.
Dehydrator - Strainer	In evaporator compartment.
Electric Choke	On engine.
Engine Overheat Alarmstat	On engine.
Evaporator	In roof at rear of vehicle.
Expansion Valve	In evaporator compartment.
Filters, Air	In evaporator compartment.
Fuel Solenoid Shut-off Valve	Behind engine air cleaner.
Fuel Tank	In body behind left rear wheel.
High-Low Pressure Switch	On engine.
Magnetic Switch, Evaporator Blower	In evaporator compartment.
Magnetic Valve, Bypass Shutter	In Diesel engine right-hand compt.
Magnet Valve, Throttle Control	On bulkhead in unit comp't.
Oil Filter, Engine	In unit compartment.
Relay, Fresh Air Blower	In driver's control box.
Relay, Ignition	In unit comp't control box.
Startix	On engine.
Surge Tank	In body above engine.
Thermostat, Fresh Air	In duct behind left-hand fresh air blower.
Thermostats, Engine and Bypass	In evaporator compartment.
Ventilator Valve, Crankcase	On engine.

Operating Instructions

In This Section

DRIVER'S OPERATING INSTRUCTIONS

GENERAL

1. Keep windows closed when operating air conditioning system. Do not leave door open for excessive periods - open door only as required to admit or discharge passengers.

2. Open two exhaust ventilators in roof of coach above center aisle.

3. Blower control switch is not operative when master switch is in cooling position.

OPERATION (Fig. 5)

1. To determine if outside temperature is high enough to warrant operation of air conditioning system, turn master switch to "Cooling" position. If green (Cooling Required) tell-tale illuminates, air conditioning unit may be started. If green tell-tale does not illuminate, outside temperature is too low to warrant operation of air conditioning system.

2. Red (Low Oil) tell-tale will illuminate when master switch is placed in "Cooling" position, and will remain illuminated until engine starts and oil pressure is built up to a predetermined limit.

3. To start engine, press "Start" button. Also press "Choke" button if engine is cold.

4. If red tell-tale comes on during operation of air conditioning system and engine continues to run, low oil pressure is indicated. Stop engine immediately by turning master switch to "Off" position.

5. If red tell-tale comes on and air conditioning engine stops, overheated engine or short in electrical system is indicated. Turn master switch "Off" and report to garage.

6. If air conditioning engine stops and red tell-tale does not illuminate but green tell-tale remains illuminated, excessive high or low refrigerant pressures, or short circuit is indicated. Turn master switch to "Off" position and report to garage.

7. If temperature in coach becomes too cold or if inside of coach gets stuffy, turn master switch to "Off" position and report to garage.

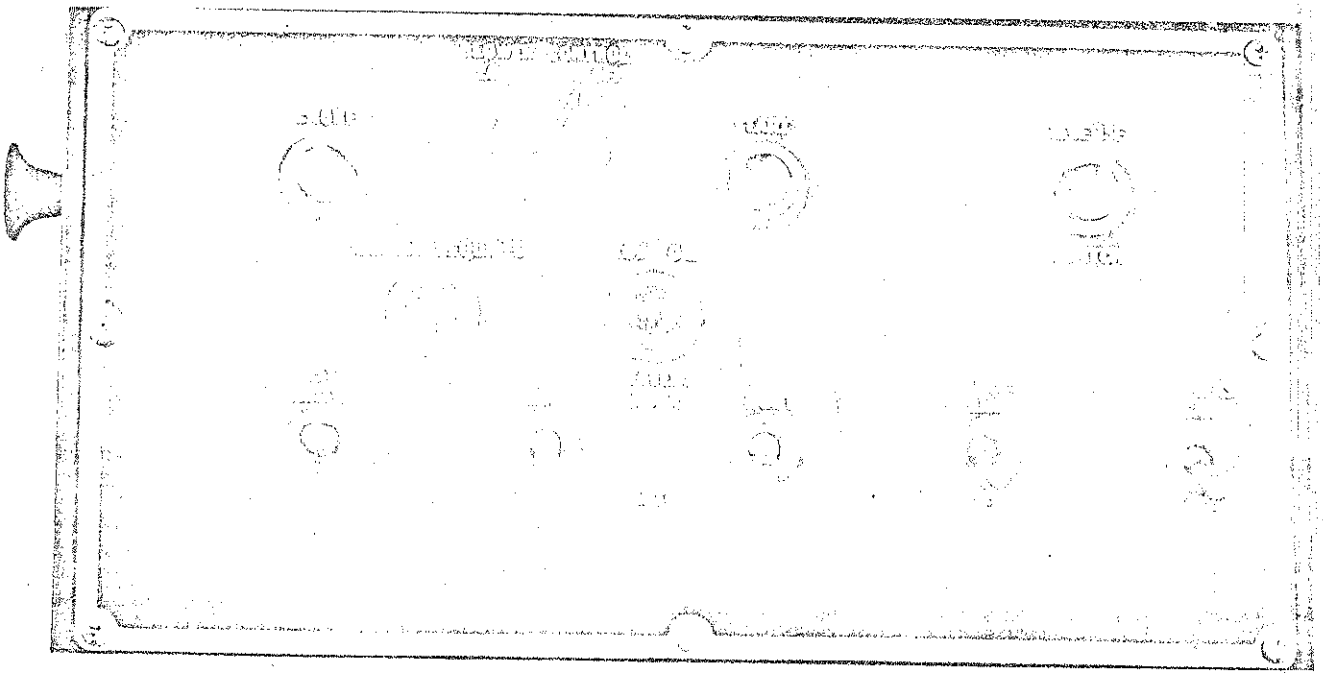


Figure 5—Driver's Control Box TP 3676

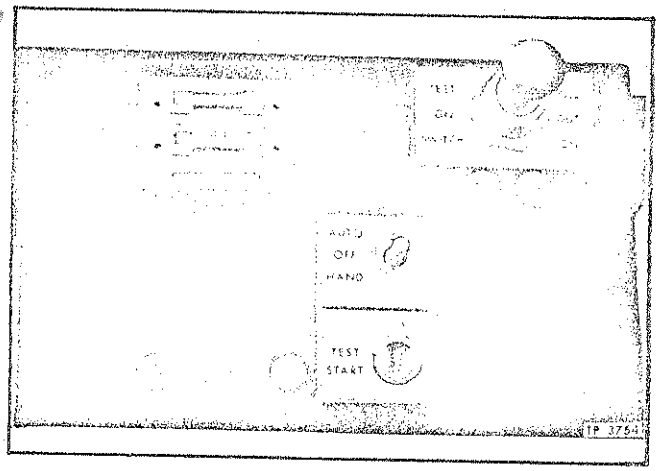


Figure 6—Air Conditioning Compartment Control Panel

OPERATING UNIT FROM AIR CONDITIONING COMPARTMENT

Control box in air conditioning unit compartment (fig. 6) is provided for use of mechanic when testing and servicing the unit. Unit may be operated by these controls without requiring the use of the master switch on the driver's control box. Doors and windows should be kept closed and roof exhaust ventilators should be open to obtain normal operation of controls.

1. Safety switch, above start button, must be in "Auto" position.

2. Pull test ignition switch handle out. This energizes throttle, ignition, and blower circuits.

3. Press "Test Start" button. If engine is cold and requires choking, press down on lever extending from electric choke housing.

4. Throttle control magnet valve on bulkhead behind control box may be opened manually and propped open if desired to run engine at low speed.

5. When service operations are completed, safety switch must be left in "Auto" position, otherwise unit cannot be started from driver's control box.

POWER PLANT FUEL SUPPLY

Fuel tank is mounted in left-hand side of coach, immediately behind left rear wheelhouse. Fuel tank capacity is approximately 20 gallons.

Gasoline used should have a minimum octane rating of 73. One-half pint of S.A.E. 10 engine oil should be added to each 12 gallons of gasoline. Quantity and viscosity of oil are important.

POWER PLANT ENGINE OIL

Engine oil of highest quality should be used. S.A.E. 20 engine oil should be used for first 100 hours of service. Thereafter S.A.E. 30 should be used. Crankcase capacity is 5-1/2 qts.

Oil level dipstick is attached to oil filler cap. Oil level should be maintained to level of mark near top of dipstick.

Oils vary in lubricating qualities and in stability. A highly refined petroleum oil containing adequate amounts of suitable additives, such as oxidation inhibitors, is essential for satisfactory performance in air conditioning service.

Individual supplier is responsible for quality of oil. The oil must not contain organic acids, saponifiable oils, soaps, or other agents that may cause corrosion, and it must not develop harmful acidic compounds under normal operating conditions.

Oil filter cartridge should be replaced when engine oil is changed.

POWER PLANT ENGINE WATER

Engine cooling system is filled through filler neck on surge tank, mounted in coach body above rear end of air conditioning unit compartment. Drain plug is located at bottom of radiator.

Cooling system capacity is 9 quarts.

The use of either of the following rust inhibitors is recommended.

GMC cooling System Rust Inhibitor - use according to instructions on container.

Potassium bichromate - use 2 ounces for each 5 gallons of water.

Soluble Oil - Not to exceed 1% of the total volumn of the system.

System Maintenance

In This Section

The instructions in this section include a brief description of the internal operation of the major units, together with adjustment and light maintenance instructions.

COMPRESSOR

The compressor (fig. 7) is a rotary type, two stage unit having ten vanes in each stage. It is self-lubricating and self-contained. The shaft seal is of special construction, having "Corprene" gaskets which are resistant to oil and heat. The seal faces are flood oiled under pressure at all times. Sight glass on side of compressor shows the oil level. Shut-off valves are provided at the compressor suction and discharge ports. Poppet type check valve in compressor intake port prevents high pressure refrigerant returning to the low side of the system. Magnetic drain plug in bottom of compressor collects any steel particles that may be present in oil due to wear.

COMPRESSOR OPERATION (Fig. 7)

Compressor is bolted to engine flywheel housing and is driven by a four pin coupling. Pins in coupling hub engage rubber bushed holes in engine flywheel. The main shell of the compressor is divided into two compartments by the front bearing cover. The rear compartment is the housing for the compressor itself and is the intermediate pressure refrigerant chamber; the compartment ahead of the front bearing cover is the low pressure refrigerant chamber.

The compression circuit carries the refrigerant gas from the front compartment at suction pressure through a strainer screen (15) then through drilled ports (4), where the gas is trapped by the pocket formed between vanes and walls of cylinder. When gas is compressed by the rotation of the eccentric mounted rotor, it is discharged through a series of holes in the cylinder wall (17) into the rear chamber under intermediate pressure. Then the gas, at intermediate pressure, is picked up by the second stage pump through intake ports (2) and the gas is further compressed. High pressure gas is discharged from the second stage pump directly into the high pressure refrigerant line leading to the condenser.

COMPRESSOR LUBRICATION (Fig. 7)

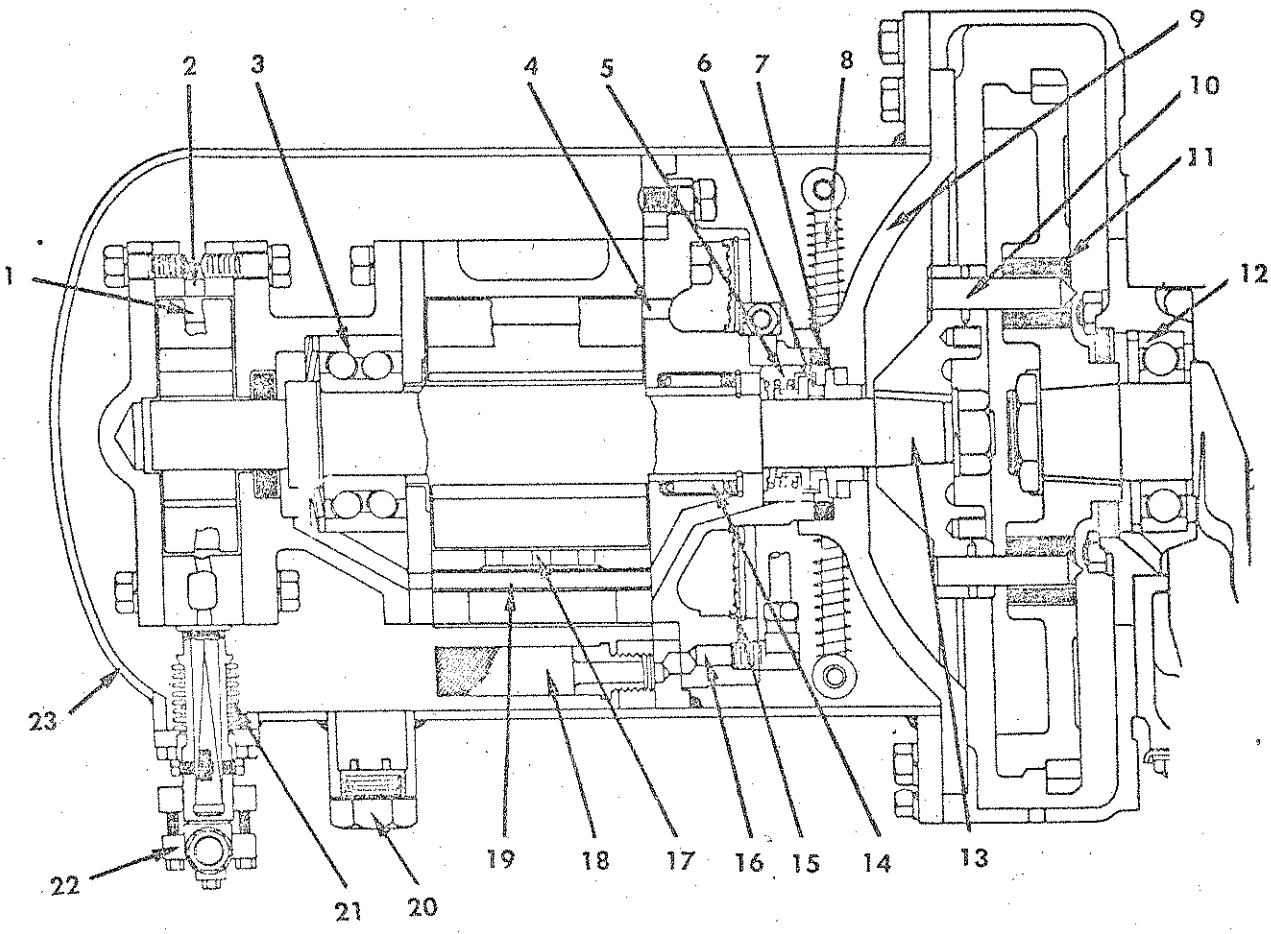
Compressor lubrication is accomplished through the difference in pressures in the front (suction) compartment and in the rear (intermediate pressure) compartment. The rear compartment is used as the oil reservoir and a loop of finned tubing in the front compartment leads from a tapped opening (16) in the bearing cover to the front bearing and seal compartment (5). As oil passes through finned tube, it is cooled by the low temperature of the suction gas surrounding the tube. The difference in pressure between the two compartments causes the oil to flow into the front bearing and seal compartment (5), and from there to the rear bearing through drilled passages in the bearing plates and a copper duct (19) connecting them. The oil thus reaching the rear bearing seeps into the first stage compressor unit to lubricate the vanes, rotor, and cylinder, and is discharged into the intermediate chamber with the refrigerant gas at discharge ports (17). Part of this oil settles in the sump for recirculation; the rest, remaining in suspension with the refrigerant gas, passes through the second stage compressor and is circulated with the refrigerant through the system, returning to the compressor through the suction line. Strainer screen (18) is installed in the lead from the oil sump to prevent passage of foreign particles into the oil circulating system.

COMPRESSOR SHUT-OFF VALVES

Double seating shut-off valves are provided at compressor discharge and suction parts. With valve stems all the way in (closed), compressor

is isolated from system for performing service operations on compressor. Valve stems are turned all the way out (fully open) for making gauge connections or when disconnecting the high-low pressure cut-out switch refrigerant lines. "Operating position" of valves, frequently referred to in this manual, is with the valve cracked from fully open position 1/2 to 1 turn to admit system pressures into the gauge and high-low pressure cut-out switch tee fittings.

IMPORTANT: Valve caps with gaskets must be in place and tight at all times.



1 Second Stage Compressor - Large Clearance - Intake Side
2 Intake Ports of Second Stage Compressor
3 Double Row Rear Ball Bearings
4 Intake Ports of First Stage Compressor
5 Front Bearing and Seal Compartment
6 Compressor Shaft Refrigerant Seal
7 Front Bearing and Seal Compartment Packing
8 Finned Tube Oil Cooling Line
9 Compressor Front Cover
10 Four-Pin Compressor Drive Coupling
11 Rubber Bushings in Engine Flywheel
12 Engine Rear Main Bearing
13 Compressor Shaft
14 Front Needle Bearing
15 Refrigerant Intake Screen
16 Lubricating Oil Passages
17 First Stage Compressor Discharge Ports
18 Lubricating Oil Strainer
19 Copper Tube Carrying Oil to Rear Bearing
20 Magnetic Oil Drain Plug
21 Flexible Connection From High Pressure Discharge to Outside Refrigerant Line
22 Compressor Discharge Shut-off Valve
23 Compressor Shell

TP 3758

Figure 7—Sectional View of Compressor

COMPRESSOR OIL

Only S.A.E. 60 engine oil, purchased from a reputable refinery in sealed quart cans, should be used in compressor. Never use bulk oil or oil which has been exposed to air.

The initial charge of oil in the compressor is 3 pints. After unit has been operated for about 10 minutes, oil level should be at bottom of sight glass. If more than 1/4 inch below bottom of glass, oil should be added. Never check oil level with compressor stopped.

Before adding oil, first determine and correct cause of loss of oil. To add oil to a charged system, first pump down the system as directed later, then add oil through oil filler plug in top of compressor shell. Add sufficient oil to bring level up to bottom of glass when running. Do not add more oil than necessary.

COMPRESSOR MAINTENANCE

Compressor requires practically no maintenance other than making sure that sufficient (but not too much) oil and refrigerant is maintained in system at all times. The lubrication system of the compressor will fail if the system loses its charge of oil or refrigerant. Both oil and refrigerant must be circulating through the compressor whenever it is running to prevent very serious damage.

Check compressor mounting bolts periodically and tighten as necessary. Check carefully for indication of oil or refrigerant leakage. Leaks should be remedied promptly to prevent excessive refrigerant and oil loss.

COMPRESSOR SHAFT SEAL (Fig. 7)

Compressor shaft seal must be in good condition to prevent leakage of refrigerant gas and oil into the engine flywheel housing. Seal consists basically of two optically flat rings, one stationery in compressor front cover and other rotating with compressor shaft. Rotating seal is spring loaded against stationery seal.

To change seal, pump down system, remove compressor from engine, and remove compressor coupling hub from shaft. The entire seal should then be withdrawn from the shaft and a complete new set of seal parts installed. When installing front cover, be sure the sealhouse packing (7) and the cover gasket are not damaged. Draw bolts down evenly to avoid cocking the cover and risking a blown gasket after unit is restored to service.

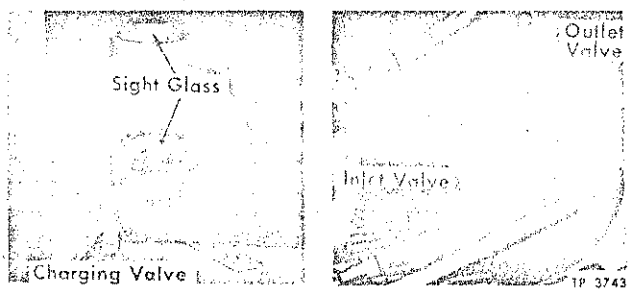


Figure 8—Liquid Receiver

CONDENSER

THE IMPORTANCE OF KEEPING THE CONDENSER CLEAN CANNOT BE OVEREMPHASIZED.

When condenser becomes clogged or coated with dirt and road film, high head pressure and overloading of engine result. Condenser must be cleaned at frequent intervals.

A combination of water and air pressures is most satisfactory for loosening and removing dirt from condenser. Air pressure should not be high enough to bend fins.

Front end of condenser may be swung outward approximately 45 degrees after removing one mounting bolt from each front corner. This permits cleaning unit from inner side, and provides access to refrigerant line connections and to engine radiator.

LIQUID RECEIVER

Liquid receiver (fig. 8) maintains a constant supply of liquid refrigerant ready for use in the evaporator. Receiver has two sight glasses; by applying flashlight to top glass, refrigerant level may be readily seen in end sight glass. After unit has been running for 10 minutes or more, refrigerant level should be at middle of sight glass. In no case should the refrigerant level be above the sight glass or below it. Refrigerant can be added to or removed from receiver through its charging valve as directed later.

During operation of system, charging valve must be closed and both the inlet and outlet valves must be open. To determine if valves are open, remove valve cap nuts and turn handle counterclockwise, using open end wrench or 8-point socket of correct size.

If air conditioning fails to function and compressor is being driven properly, receiver valves should be the first place to check - system positively will not function unless both of these valves are open.

Keep receiver mounting bolts tight and make sure valve caps are in place at all times.

REFRIGERANT DEHYDRATOR-STRAINER

Dehydrator-strainer (fig. 9) installed in liquid line in evaporator compartment, removes foreign matter and moisture from the liquid refrigerant

before it reaches the expansion valve. Filter sock is filled with Silica-Gel, which has a high moisture absorbing capacity, thus any moisture which has been inadvertently admitted into system will be absorbed by the Silica-Gel. This does not mean that extreme caution should not be followed when making an installation or that it is unnecessary to evacuate the system.

Dehydrator-strainer should be serviced whenever the system has been opened as follows:

1. Pump down system as directed later.
2. Remove cap and spring, then pull cartridge out of shell.
3. Remove filters and Silica-Gel from strainer screens. Discard old Silica-Gel.
4. Wash felt filters and screen with carbon tetrachloride.
5. Place strainer felt in screen over inlet tube, install felt tube in screen, fill with new Silica-Gel (8 ounces) then place felt on top of Silica-Gel. Install cover on screen and attach with screws.
6. Place cartridge in shell and install spring and cover. Make sure cover gasket is in good condition.

EXPANSION VALVE

OPERATION

Expansion valve (fig. 10) is a multi-outlet thermo valve with external remote control bulb and external equalizer. Expansion valve regulates flow of refrigerant into evaporator. Valve is primarily operated by the temperature of the suction gas leaving the evaporator, and is further controlled by the suction pressure in the evaporator through the equalizer tube. The combined effect of these two factors automatically control the quantity of liquid admitted into the evaporator.

Outlet end of valve is installed in distributor flange, which is connected by several small tubes to the evaporator coils. Liquid line is connected to inlet port which extends through the center of the distributor flange. Remote bulb is attached to suction line near evaporator outlet, where it is subjected to temperature of suction gas as it leaves the evaporator. Bulb is charged with Freon which expands and contracts in accordance with the temperature of the suction gas. Expansion of gas in bulb applies pressure to top of diaphragm in power assembly in expansion valve, causing valve to open.

Bulb tends to operate valve toward its open or closed position to regulate flow of refrigerant into the evaporation as required. If too much liquid is admitted into evaporator all of it does not evaporate and some liquid approaches the remote bulb, lowering its temperature. This will cause the gas in the bulb to contract, relieving pressure on diaphragm, and spring moves valve toward its closed position. If there is not enough liquid admitted into the evaporator, increase in temperature of suction gas raises temperature of bulb, causing valve to operate in its opening direction.

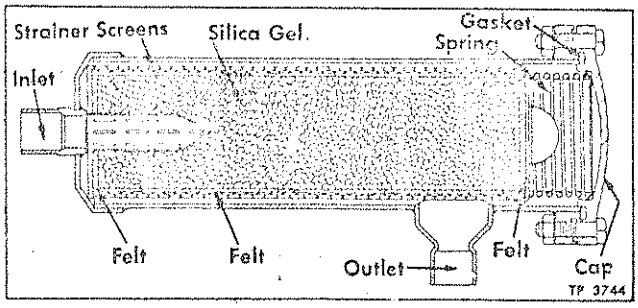


Figure 9—Refrigerant Dehydrator—Strainer

EXTERNAL EQUALIZER

Purpose of external equalizer is to prevent flooding the evaporator coils when temperature of evaporator suddenly rises. Equalizer tube is connected into evaporator coil beyond the expansion valve outlet and to cavity below diaphragm in power assembly. This, when valve is suddenly opened wide by a high temperature in the suction gas, heavy flow of liquid into the evaporator creates high pressure which is carried to the diaphragm

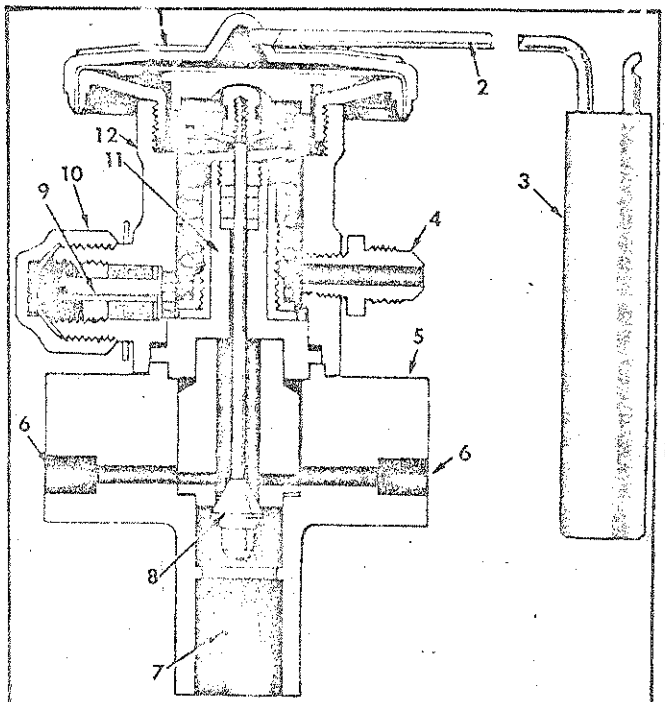


Figure 10—Sectional View of Expansion Valve

through the equalizer tube. This pressure below the diaphragm counteracts the pressure from the remote bulb and tends to move the valve toward its closed position.

CONSTRUCTION

Expansion valve has three component parts: Power assembly, cage assembly, and body flange. There are no working parts in the body flange. Multi-outlet body flange is connected to evaporator by tubes with soldered connections. Power assembly and cage assembly can be removed from body flange without breaking the line connections.

Always make sure that the system is clean and dry before installing the expansion valve.

LOCATION OF REMOTE BULB

Remote bulb is attached to suction line near evaporator outlet. Always install bulb in same location as original factory installation (45 degrees off top of suction line). Clamp bulb securely to suction line, then insulate bulb and suction line together for a distance of at least 18 inches. Never apply heat near remote bulb location without first removing the bulb.

SUPERHEAT

Superheat is the temperature increase above the saturation point. When the liquid Freon boils or evaporates in the evaporator, heat is absorbed from the air passing through the evaporator, but the temperature of the gas does not raise above the boiling point until all of the liquid has changed to gas. The heat thus absorbed is the latent heat of vaporization, producing a change in state with no change in temperature.

After the refrigerant has changed to gas, the temperature of the gas is still lower than that of the air passing through the evaporator, so the gas will continue to absorb heat from the air and its temperature will rise a few degrees. This amount of rise above saturation temperature is called "Superheat."

Example: At 37 pounds gauge pressure, the saturation temperature of Freon is 40°F.; that is, the liquid changes to gas at 40°F. If the temperature of the Freon gas at 37 pounds gauge pressure is 48°F., the gas contains 8° of superheat. Superheating takes place after all the liquid has changed to gas, usually near the outlet of the evaporator coils.

PRESSURE-TEMPERATURE

Pressure has a very definite relationship to the boiling point of any substance. There is a definite temperature at which a liquid will boil for every definite pressure exerted upon that liquid. Water, which boils at 212°F. under zero gauge pressure (atmospheric pressure at sea level), will boil at 162°F. under 10 inches of vacuum. Likewise, Freon boils at -22°F. (22° below zero) at atmospheric pressure and at 40°F. under 37 pounds gauge pressure. An increase in pressure causes a rise in the boiling point.

The pressure-temperature relationships shown in the table are used for two purposes. For adjusting the expansion valve and for checking for air in the system. Method of checking for air is described later.

FREON-12 PRESSURE-TEMPERATURE RELATIONSHIP

Temp. °F.	Gauge Pressure PSI	Temp. °F.	Gauge Pressure PSI
30	28	96	110
32	30	98	113
34	32	100	117
36	33	102	121
38	35	104	124
40	37	106	128
42	39	108	132
44	41	110	136
46	43	112	140
48	45	114	144
50	47	116	148
52	49	118	153
54	51	120	157
56	53	122	162
58	55	124	166
60	58	126	171
62	60	128	175
64	62	130	180
66	65	132	185
68	68	134	190
70	70	136	195
72	73	138	200
74	76	140	206
76	78	142	211
78	81	144	216
80	84	146	221
82	87	148	227
84	90	150	234
86	93	152	239
88	96	154	245
90	100	156	251
92	103	158	256
94	106	160	262

EXPANSION VALVE ADJUSTMENT (Fig. 10)

Adjust valve to obtain 6° - 8° superheat with moderately heavy internal load. Refer to pressure - temperature chart. Adjustment is made as follows:

1. Strap bulb of remote reading thermometer to suction line as near to expansion valve thermobulb as possible.

2. Connect low pressure gauge to evaporator outlet valve. To connect gauge, remove cap from

shut-off valve and turn valve stem counterclockwise as far as possible. Remove plug from gauge port and connect gauge, leaving connection slightly loose at gauge end. Slightly crack valve, then tighten gauge connection as soon as Freon gas displaces all air in gauge line.

3. Remove cap from expansion valve stem. Turn valve to right to increase superheat. Turn stem to left (counterclockwise) to increase refrigerant flow and lower superheat. Four complete turns of the valve stem will change the actuating superheat approximately 2°F.

4. After adjusting, wait about 30 minutes to check results.

5. To remove gauge, back valve stem out until valve seats, remove gauge, and install plug in gauge port. Replace valve cap.

SERVICING (Fig. 10)

When necessary to clean, inspect, or replace parts, power assembly and cage assembly may be removed without disconnecting any soldered joints in refrigerant lines.

1. Pump down the system as directed later.

2. Disconnect external equalizer line from power assembly. Remove two cap screws attaching power assembly to distributing flange, remove power assembly, and lift out cage assembly.

3. When assembling valve, replace gaskets in proper places, and be sure that the retaining pin on the valve cage engages the slot in the distributing flange.

4. Make sure the two lugs on the valve cage fit into the grooves in the power assembly, and that the gear wheel on cage assembly meshes with adjusting gear in side of power assembly.

5. Do not force valve together - make the cage fit properly before tightening to the distributing flange.

CAUTION: When soldered connections are made at valve, remove power assembly, cage assembly, and all gaskets. Keep heat away from all valve parts except the distributing flange.

EXPANSION VALVE FREEZES

Expansion valve trouble caused by moisture may be usually detected by an intermittent hissing sound at the expansion valve at high temperatures. Do not confuse this hissing sound with the hissing caused by an overcharge of Freon. Excessive Freon causes a hissing sound accompanied by a pounding vibration. When operating at low temperatures, moisture is indicated by the above, and by the fact that when the compressor is shut down and the valve warms up, it will become operative again for a short time.

Do not apply a torch to valve body to melt ice accumulation at valve seat. If necessary to apply heat, use a cloth soaked in hot water. This is equally effective and less dangerous.

If there is moisture in the system, it is necessary to disassemble dehydrator and install new charge of Silica-Gel. If moisture is still evident after one hour of operation, Silica-Gel must be renewed again. Repeat this operation until all moisture has been eliminated. Moisture trouble is caused by moist air in piping when system is open, or from water in Freon container. Piping should be blown out with refrigerant before making final connections, particularly if tubing has been open to air with high humidity content. After system has been pumped down and system opened, moisture is almost certain to be introduced. Always install new Silica-Gel in dehydrator whenever system has been opened.

Many chemical preparations to be added to the refrigerant are now offered commercially for correcting moisture trouble. These preparations are anti-freeze solutions and are not suitable for use in rotary compressor used in this system. The best practice is to always service the dehydrater whenever the system has been opened. This absorbs the moisture rather than preventing it from freezing, and also eliminates the danger of corrosion of internal parts of system caused by the presence of moisture.

EVAPORATOR

Finned tube type evaporator is mounted in roof at rear of coach. The only maintenance required is periodic cleaning of evaporator and drip pan. These units, because they are wet, are bound to pick up minute particles of dust, lint, etc., if filters are not cleaned frequently enough, and must be cleaned with steam or hot water and some cleaning agent which is not harmful to the aluminum fins or copper tubes. This is particularly important when operating in humid climates, since objectionable odors may originate at the evaporator and may be caused by a mold-like formation or growth.

Evaporator is equipped with inlet and outlet shut-off valves. Both valves must be open when operating system. Make sure valve caps with gaskets are in place at all times and that all mounting bolts are kept tight.

FRESH AIR BLOWERS AND RELAY

BLOWER MOTORS

Fresh air blower motors require no maintenance, and should operate indefinitely without attention. In the event of failure motor can be disassembled, brushes replaced, and commutator turned and undercut in accordance with established practice. Do not turn commutator more than necessary to obtain smooth surface.

Whenever motor is disassembled, bearings should be lubricated at reassembly.

BLOWER RELAY

Blower relay wiring connections are shown in figure 4.

When current is supplied to "Vac." terminal of relay, coil is energized, closing relay contact points. Battery current supplied to "Bat." terminal flows through points and "Sol." terminal to operate blower motors.

Service procedures are same as for ignition relay. Refer to "Ignition Relay" in Power Plant Maintenance section of this manual. Specifications are listed at end of this section.

AIR FILTERS

Five air filters are provided, three for filtering recirculated air, and two for filtering fresh air. Recirculated air filters are mounted on top side of evaporator compartment door and are accessible when door is open. Fresh air filters, one in each end of evaporator compartment, stand on edge and filter the fresh air as it enters the evaporator compartment. These filters are removed by removing narrow access plates from ceiling directly below filters.

AIR FILTERS MUST BE KEPT CLEAN FOR SATISFACTORY OPERATION OF AIR CONDITIONING SYSTEM.

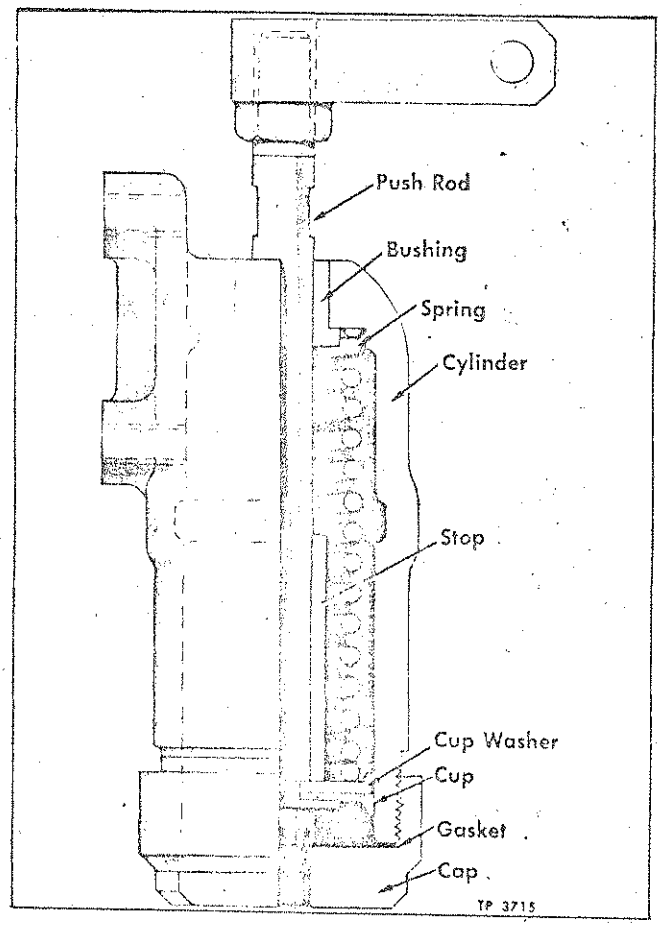


Figure 11—Evaporator By-Pass Shutter Control Cylinder

Clogged filters restrict air circulation, thus reducing efficiency of system. In addition to the effect on system operation, dirty filters will permit dirt to pass into the evaporator coil. Effect of dirt on evaporator coils is explained under "Evaporator" in this section.

Filters are made of galvanized wire cloth. Filters should be removed frequently and thoroughly washed. Filters should be coated sparingly with odorless oil.

SHUTTER CONTROL CYLINDER

Bypass shutter control cylinder (fig. 11) piston should be sparingly lubricated with chassis grease at assembly.

To check for air pressure leakage past piston cup, admit air pressure to cylinder and apply soap suds where push rod comes out of cylinder. If leakage is excessive, replace piston cup. When installing new cup, tighten retaining nut on push rod snugly, but not tight. Excessive tightening will distort cup and cause air pressure leakage.

CONTROL CYLINDER MAGNET VALVE

Pressure type magnet valve (fig. 12), mounted on bulkhead in right-hand side of Diesel engine compartment, controls air pressure to bypass shutter

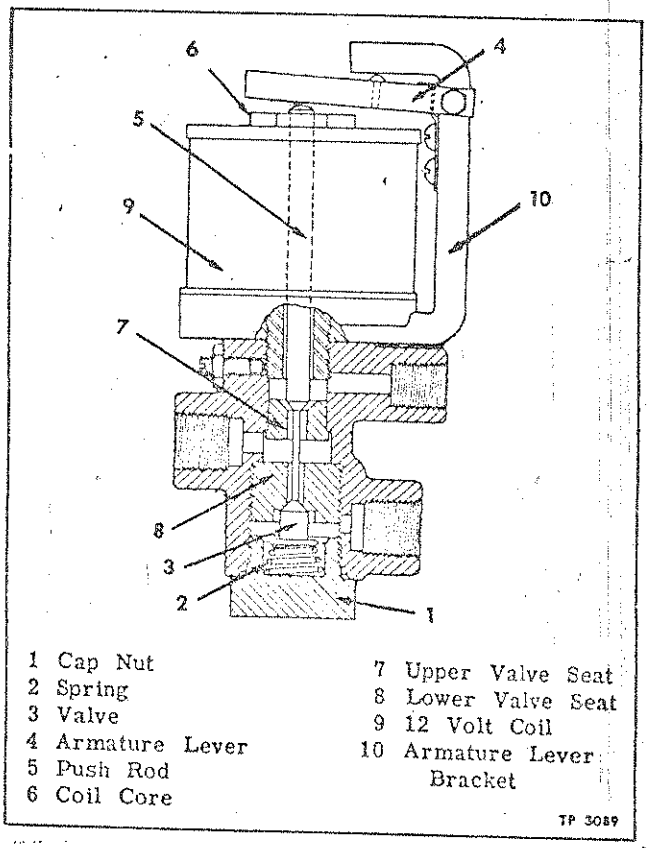


Figure 12—By-Pass Shutter Control Magnet Valve

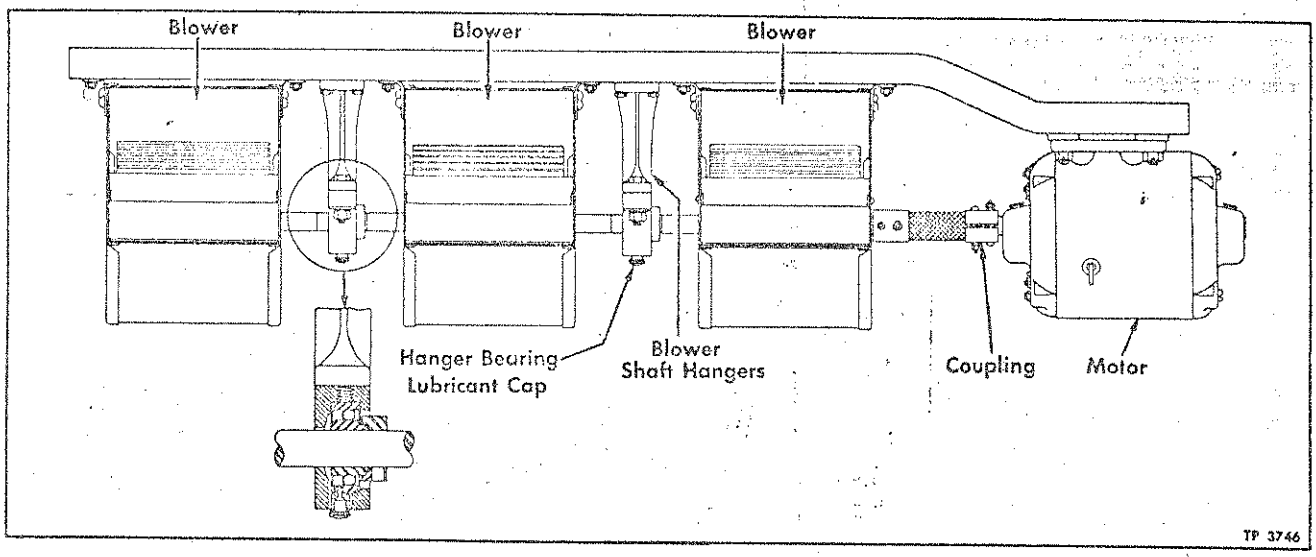


Figure 13—Evaporator Blower Mounting

control cylinder. When magnet valve is energized by the bypass thermostat, air pressure passes through the valve into the shutter control cylinder. When magnet valve is de-energized, air pressure is exhausted from the control cylinder.

MAINTENANCE

Magnet valve may be tested for air leaks around air line fittings and valve stem by applying soap suds and noting if air bubbles appear.

Air gap between armature lever and coil core should be .032"-.042" when coil is energized. Travel of valve stem should be 1/32".

EVAPORATOR BLOWERS AND CONTROLS

BLOWERS

Evaporator blowers consist of three blowers directly connected to an electric motor. Blowers are mounted in roof as shown.

Two oilers are provided on blower motor. Oilers should be filled with S.A.E. 20 engine oil at intervals indicated on lubrication chart.

MAGNETIC SWITCH (Fig. 14)

Blower motor magnetic switch is mounted in evaporator compartment beside thermostat. Switch acts as a relay for blower motor, feeding current direct from battery cable junction to motor when master switch is in cooling position.

Inspection and Cleaning

Remove cover to inspect points, but do not clean points unless necessary. Points are silver and tend to oxidize (blacken), which does not impair efficiency. Clean points only if pitted or burned, and not if points are merely blackened. CAUTION: Do not use file or emery paper on points. Use crocus cloth or bond paper.

Point Replacement

If points are badly burned, replace contact bar. Remove split pin, washer, and contact bar from plunger pin. Install new contact bar on plunger pin, then install washer and split pin. Make sure contacts operate properly, then install switch cover.

THERMOSTATS

Three thermostats are used in air conditioning system; their function is previously described under "Operation of System Controls." These thermostats are all of same construction (fig. 15), the difference being in the temperature setting, the open and closed differential, and wiring connections. Whenever wires have been disconnected from thermostats, they must be reconnected to their original terminals or the system will not function properly.

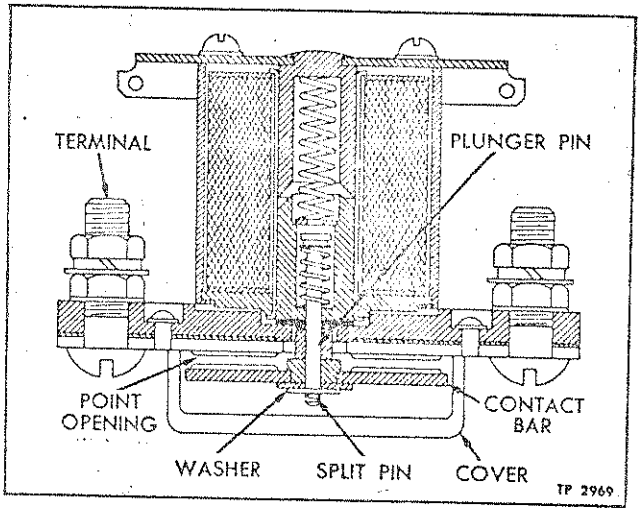


Figure 14—Evaporator Blower Magnetic Switch

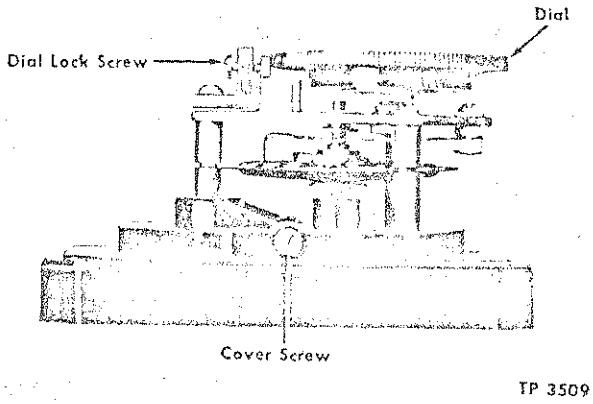


Figure 15—Thermostat With Cover Removed

Thermostats have an adjustable dial which is locked at the recommended temperature settings. When testing or adjusting thermostat dial setting, an accurate reading dial thermometer should be used, and should be placed as close to thermostat as possible. Do not touch either the thermometer or the thermostat when testing, since body heat will affect operation of both and cause an erroneous reading.

While the thermostats can be set at the desired opening or closing point by adjusting the dial, the temperature differential cannot be adjusted. Thermostats are not reparable in the field and except for the manual dial, are not adjustable. Sealed silver contacts require no cleaning and should operate indefinitely.

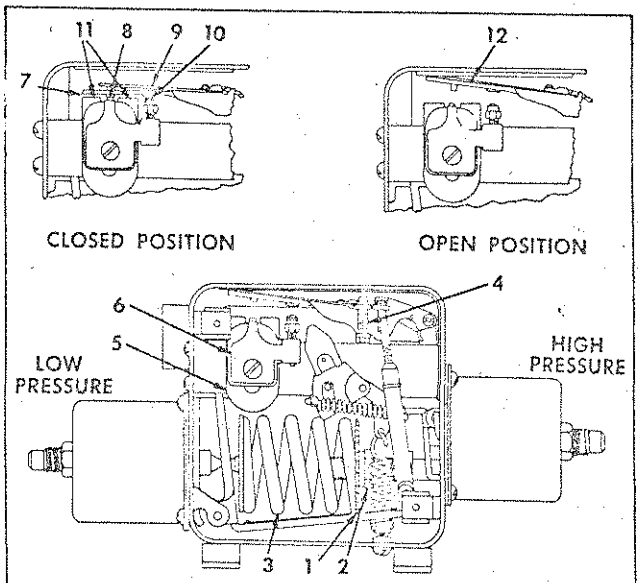
CAUTION: Any attempt to adjust or repair thermostats will undoubtedly destroy calibration. Should this occur, unit must be replaced. When installing thermostats, make sure wires are connected in same manner as on original factory installation.

Thermostat settings are as follows:

Fresh Air - open below 60°F., closed above 65°F.

Engine Speed - closed above 74°F.

Air Bypass - closed below 72°F.



1 Low Pressure Range Adjusting Nut
2 Lock Nut
3 Low Pressure Control Spring
4 Differential Adjusting Screw
5 Magnet
6 Main Contact Support
7 Clearance Between Armature and Magnet (Approx. 1/32"
8 Auxiliary Contacts
9 Note Positions of Phosphor Bronze Leaf Carrying Movable Auxiliary Contacts
10 Main Contacts
11 Surfaces of Magnet Parallel with Trip Arm
12 Note Position of Phosphor Bronze Leaf Carrying Movable Auxiliary Contacts

Figure 16—High-Low Pressure Cut-Out Switch

HIGH-LOW PRESSURE CUT-OUT SWITCH

GENERAL INFORMATION (Fig. 16)

A very small amount of high grade lubricating oil on moving parts of switch every six months will maintain operating efficiency.

Whenever cover is removed for inspection or adjustment, be sure rubber moulding is used under cover and that split in moulding is at bottom of switch housing. Rubber grommet and special bushing are used for wires at main contact assembly, and these should always be in place so that switch enclosure is dustproof.

Electrical connections are made at terminals in back of switch. Terminals are accessible after rear cover is removed. CAUTION: Make sure terminals or wires cannot interfere with the contact arm.

When making tubing connections to either the high or low pressure bellows, it is extremely important to use a wrench on nut on bellows element to prevent it from turning, as this will destroy the bellows element and will void any warranty that might otherwise apply.

TESTING LOW PRESSURE ADJUSTMENT

Low pressure cut-out is an extremely important adjustment. System will not function satisfactorily and possible damage to compressor may result if switch points fail to open near the designated pressure. In making test, an accurate compound gauge should be used. Procedure for testing low pressure adjustment is as follows:

1. Connect compound gauge to tee on compressor suction shut-off valve. Close suction

valve by turning valve stem in (clockwise) until valve seats.

2. Start engine and allow it to run until it stops, observing reading on gauge when engine stops. Switch points should open and stop engine at 7 pounds gauge pressure.

3. Next allow pressure to build up while holding start button in until engine cranks. Pressure reading on gauge when switch points close and complete starter circuit should be approximately 22 pounds.

TESTING HIGH PRESSURE CUT-OUT

High pressure cut-out and cut-in pressures are not adjustable, and are set at the factory to the proper specifications. Switch is designed to cut out at 250 pounds pressure, and should cut in when pressure drops to approximately 190 pounds. If switch does not cut out and in at these pressures, switch should be replaced. Test as follows:

1. Back compressor discharge shut-off valve out by turning valve stem counterclockwise until valve seats. Connect an accurate high pressure gauge to tee on discharge shut-off valve.

2. With both suction and discharge valves in operating position, start engine. Slowly close discharge valve and observe reading on gauge when engine stops.

3. Hold starter button in while pressures are equalizing and observe gauge reading when starter circuit is completed.

4. If engine fails to stop when pressure reaches 250 pounds, or fails to start when pressure drops to approximately 190 pounds, control switch must be replaced.

LOW PRESSURE RANGE ADJUSTMENT (Fig. 16)

This adjustment changes both the cut-in and cut-out point an equal amount.

1. With switch cover removed loosen lock nut (2). Compound gauge must be connected to suction shut-off valve with valve closed.

2. Turn range adjusting nut (1) to decrease compression on spring (3).

3. Start engine and allow to run until pressure of 7 pounds is obtained, then slowly turn adjusting nut (1) to compress spring (3) until contact points snap open. This is the cut-out position of switch.

4. If necessary to adjust the differential between cut-in and cut-out pressures, adjust as described below.

LOW PRESSURE DIFFERENTIAL (Fig. 16)

After setting switch to the desired cut-out point as described above, differential adjustment is made by changing the cut-in point only by means of the differential adjusting screw (4).

1. To widen differential (raise cut-in pressure), turn screw (4) clockwise. CAUTION: Do not set cut-in pressure above 22 pounds.

2. To narrow differential (lower cut-in pressure), turn screw (4) counterclockwise.

3. Take care not to force screw beyond its normal limits.

SOLDERED JOINTS

Success in soldering depends in a great measure on the care exercised in cleaning the surface, as solder will not adhere to a dirty or greasy surface. The following steps should be taken to prepare sweated joints:

1. Saw pipe off square, use a knife blade to remove any inside burr. Make certain that no filings and cuttings drop into pipe. Avoid sharp bends or kinks in all pipe.

2. Polish pipe and inside of fitting so metal surfaces to be sweated together are bright and clean. Use No. 00 steel wool for polishing. Do not use files, sandpaper, or emery cloth as they score the metal surfaces. Do not touch the cleaned surface with hand as the oil and perspiration will prevent the solder flowing as it should and invariably causes a leak.

3. Put a thin coat of "Nokorode" flux on the cleaned portion of both the fitting and tube. A stiff brush should be used for this purpose; NEVER USE YOUR FINGER. After the fitting is placed on the pipe, remove any excess flux that shows outside the fitting.

4. Heat the fitting as evenly as possible, allowing heat to be transferred from fitting to tube, so that the solder will flow uniformly within the joint. Never hold the flame in one spot. By touching the joint between the pipe and fitting with the special solder, 95% tin-5% antimony (which MUST be used for this type work) it is very easy to tell when the temperature has reached a degree high enough to allow the sweating to take place. When the solder flows freely into the joint the torch should be held back in order to prevent the joint from becoming too hot. Care must be taken not to get the joint too hot, as this will burn off the flux, allowing oxidation to take place, also cause the solder to harden and alloy with the copper pipe. In smaller pipe of 3/4" O.D. and under, the solder can be fed into the joint from one point, but in the larger diameters it is recommended that the solder be fed into one side then into the other. As soon as a small fillet can be seen completely around the joint the application of more solder will dripp off and not add anything toward making a better joint. Any surplus solder should be wiped off with a dry paint brush or clean cloth.

5. Permit the connection to cool until the solder becomes set. 95-5 solder sets very rapidly.

6. Occasionally, pipe ends become dented or damaged. In such cases it is recommended that the pipe end be sawed off beyond the damaged or dented section, or use a sizing tool to true up the end.

7. In sweating heavy connectors, care should be taken to allow more time for the solder to set, as these heavier fittings hold the heat longer and do not cool as quickly. The reverse is true on heating. Do not overheat the pipe while heating the fitting.

SPECIFICATIONS

COMPRESSOR
- Make ..... Ingersoll-Rand
- Model 1310C
- Rated Capacity ..... 4 Ton

DEHYDRATOR-STRAINER
- Make ..... Henry Valve Co.
- Model V-511
- Dehydrant ..... Silica-Gel
- Capacity ..... 8 ozs.

EXPANSION VALVE
- Make ..... Alco Valve Co.
- Type TP2-12FG
- Adjustment ..... External
- Setting ..... 6^{o}-8^{o} Superheat

FRESH AIR BLOWER RELAY
- Make ..... Delco Remy
- Model 1116817
- Air Gap (Points Closed) .... 0.012" - 0.017"
- Point Opening ..... 0.015" - 0.025"
- Armature Attracted to Core .... 8-10 Volts

FRESH AIR BLOWER MOTORS
- Make ..... Delco Appliance
- Model 5047437
- H.P. 1/25
- Volts, D.C. 13
- Current (Amperes) 4.5
- R.P.M. 1650
- Rotation ..... See Wiring Diagram (Fig. 4)

BYPASS SHUTTER MAGNET VALVE
- Make ..... National Pneumatic
- Type ..... Pressure
- Model C-26120
- Valve Travel ..... 1/32"
- Gap - Lever to core (lever down) ..... 0.032" - 0.042"

EVAPORATOR BLOWER MOTOR
- Make ..... Delco Appliance
- Model 5327374
- H.P. 1/4

EVAPORATOR BLOWER MOTOR (Cont'd.)
- Volts, D.C. 12
- R.P.M. 1325
- Rotation (Commutator End) .. Counterclockwise

EVAPORATOR BLOWER MAGNET SWITCH
- Make. ..... Cutler Hammer
- Type ..... SPST, Continuous duty
- Volts 12
- Current ..... 0.046 Amps

THERMOSTATS

Fresh Air
- Make ..... Spencer
- No. B6490-3
- Type RT2C-125
- Use Terminal Numbers ..... 1 & 2
- Open ..... Below 60^{o}F.
- Closed ..... Above 65^{o}F.
- Dial Locked at ..... 62^{o}F.

Air Bypass
- Make ..... Spencer
- Number B6490-2
- Type RT2-30
- Use Terminal Numbers ..... 1 & 3
- Closed ..... Below 72^{o}F.

Engine Modulation
- Make ..... Spencer
- Number B6490-1
- Type RT2C-30
- Use Terminal Numbers ..... 1 & 2
- Closed ..... Above 74^{o}F.

HIGH-LOW PRESSURE CUT-OUT SWITCH
- Make ..... Penn Electric Switch Co.
- Type ..... LS
- Model ..... LSP

High Pressure Switch
- Opens at ..... 250 lbs. gauge pressure
- Closes at ..... 190 lbs. gauge pressure

Low Pressure Switch
- Opens at ..... 7 lbs. gauge pressure
- Closes at ..... 22 lbs. gauge pressure

Power Plant Maintenance

IN THIS SECTION

ENGINE

Four cylinder, four-cycle gasoline engine is of conventional L-head type. Engine operates at only two speeds -- 1400 rpm and 2400 rpm. Speed of engine is automatically controlled by "Engine Modulation" thermostat located in evaporator compartment. Engine speed is maintained by gear-driven, fly-ball type governor.

For test and adjustment purposes, engine may be operated and controlled from air conditioning compartment, as described earlier in this manual. Such control is essential, since in cool weather, thermostat action may prevent starting engine from driver's controls, or may keep engine operating at slow speed (1400 rpm).

NOTE: The terms "Front" and "Rear" as applied to the engine do not relate to position of engine in coach. These terms follow common usage as applied to engines. "Front" designates timing gear end, while "Rear" designates flywheel end. "Right" and "left" are applied as viewed from flywheel end.

LUBRICATION & INSPECTION

Reference should be made to "Lubrication and Inspection" section of this manual for necessary inspection, servicing, and lubrication of the power plant. Intervals given are for average operating conditions.

It should be kept in mind that as temperature of air increases, compressor load on engine also increases; therefore, under conditions of prolonged high temperature, frequency of inspection and maintenance should also be increased.

The importance of regular and proper inspection, maintenance, and lubrication cannot be over-emphasized.

ENGINE TUNE-UP

Engine should be tuned at intervals of 50 hours of operation.

GENERAL

(Refer to alphabetical index at front of manual for specific page on which various subjects referred to throughout this section may be found).

Results obtained from an engine tune-up may be unsatisfactory if a "hit and miss" method is used instead of a systematic approach to the job; therefore the logical solution is a complete check-up following and carrying out each step as directed below.

NOTE: Before tune-up procedure is started it is important that air cleaner, crankcase breather, and crankcase ventilator valve be serviced as shown later in manual. Reference should be made to "Trouble Shooting" for engine operating trouble symptoms and causes.

COMPRESSION TEST

Compression test is made to determine the need of internal repairs before tune-up procedures are accomplished. This test will indicate condition of piston rings and valve mechanism. Compression pressure depends upon cranking speed, engine temperature, oil viscosity, compression ratio, and condition of the engine. An engine without fairly even compression cannot be successfully tuned. Make test in the following manner:

1. Remove all spark plugs. Disconnect high tension wire from center of ignition coil. Insert compression gauge in No. 1 spark plug hole. Crank engine 10 or 12 turns with starter. Note highest gauge reading while engine is being cranked. Take a reading at each cylinder in the same manner.

2. Analyze the readings. While readings on some engines may be higher than on others due to conditions mentioned above, the readings in any one engine should be reasonably high (100 lbs. or more), and all cylinders should show uniform readings within approximately 10 pounds.

3. Should one or more cylinders show reading indicating low compression, pour a liberal amount of light engine oil through spark plug hole in

cylinder having low reading. Allow sufficient time for oil to spread around rings, then take another reading. If compression is appreciably increased in cylinder so treated, piston or rings require replacement. If no change in compression reading is noted, check the valve mechanism.

4. An extremely low reading in two adjacent cylinders may indicate a cylinder head gasket leak.

TUNE-UP SEQUENCE

1. Spark Plugs. Refer to "Spark Plugs," later in this manual for detail instructions.

a. Check to be sure that proper make and type are being used.

b. Clean plugs, using an abrasive blast-type spark plug cleaner.

c. Inspect procelain. If cracked or broken, replace spark plug.

d. Set spark plug gap to dimension given under "Specifications" later in this section, using a round feeler gauge. When regapping is necessary adjust side electrode only. Do not bend center electrode.

e. Be sure plug is installed firmly and that gasket is in good condition.

CAUTION: Tighten plug until it bottoms on gasket, then tighten an additional 1/4 to 1/2 turn.

2. Battery and Wiring. Refer to applicable coach manual for information on battery.

a. Check engine ground strap. Be sure strap is in good condition and terminals are clean and tight.

b. Check starter and startix cables. Be sure cable is in good condition and terminals are clean and tight.

c. Check spark plug cables and other ignition wires. Terminals on each end must be tight and clean. If insulation shows evidence of deterioration cables or wires should be replaced.

3. Distributor. Refer to "Distributor," later in this manual for detail information.

a. Check distributor points for pitting or burned condition. Replace points if they cannot be cleaned up or filed. Do not use emery cloth to clean distributor points.

b. Check point opening with feeler gauge. Refer to "Specifications" later in this section for breaker point opening.

c. Check distributor cap. Replace if cracked or if posts are burned appreciably.

d. Check rotor to be sure spring contacts secondary terminal and that point is not burned from arcing.

e. Check condenser for efficiency of operation.

4. Ignition Timing. Refer to "Ignition Timing," later in this manual for detail information.

a. Check ignition timing to be sure No. 1 cylinder is firing according to flywheel markings.

b. Set manual advance to suit quality of fuel being used.

5. Valve Clearance. Refer to "Specifications" later in this manual for detail information.

a. Tighten cylinder head studs to tension given in "Specifications" later in this section.

b. Check valve lash against clearances listed in "Specifications" later in this section.

c. Make visual inspection of valve springs for pits or fractures.

6. Carbureter. Refer to "Fuel System" later in this manual for detail information.

a. Check carbureter flange and intake manifold gasket for leaks.

b. Check float level. Refer to "Specifications" later in this section for dimension.

c. Adjust low speed screw until engine runs evenly and steadily. Engine must be thoroughly warmed up before adjusting carbureter.

VACUUM GAUGE TEST

The vacuum gauge, when used according to manufacturer's direction, is a useful aid to engine tune-up. With it one may quickly localize such conditions as listed below.

Use of Vacuum Gauge

Remove crankcase ventilator valve to manifold tube then attach vacuum gauge to intake manifold. Disconnect ball stud on carburetor linkage from governor lever, and operate throttle by hand. CAUTION: Do not permit engine to overspeed. With carbureter adjustments made as given above, run engine at normal idling spped. Vacuum gauge reading should be about 18 to 21 inches, and indicator should be steady. Diagnosis of engine condition can be made by observing action of gauge as follows:

1. Gauge action with engine running at idling speed. If indicator drops several inches at regular intervals the cause is generally valve sticking or defective spark plug.

2. If indicator drops occasionally a spark plug is not firing or the gap is set too close.

3. If the reading is low with a steady indicator, the causes may be late ignition timing, leaky manifold gaskets, or valves adjusted too tight.

4. If the reading is high with indicator varying from 6 to 12 inches every revolution, the cause is generally late valve timing.

5. Gauge action on acceleration and deceleration. With engine idling, open throttle quickly. Vacuum should fall to 2 inches. Close throttle. Gauge should then read at least 24 inches. If reading is low on deceleration, diluted oil or defective piston rings usually are the cause.

IGNITION SYSTEM

All current for ignition system is obtained from 12-volt vehicle battery and generator. Ignition system consists of source of power, ignition relay, ignition coil, distributor, condenser, spark plugs, and high and low tension wiring. Also connected in, and affecting, ignition system is the engine alarmstat which is covered earlier under "System Operation."

Ignition system functions to produce and deliver high voltage surges to correct spark plug at correct intervals, and with correct timing, to engine. Each high voltage surge produces a spark at the spark plug gap to which it is delivered, so that the mixture of air and fuel in the cylinder is ignited.

IGNITION CIRCUITS

There are two distinct electrical circuits in the ignition system, the primary and the secondary. When these electrical circuits are kept in mind as well as the functions of the various units in the system to accomplish these circuits, a better understanding may be had of the operation of the entire system.

Primary Circuit. The primary, or low tension circuit, includes the source of electrical energy, ignition relay, distributor contact points and circuit breaker mechanism, primary winding of the ignition coil, and condenser.

Secondary Circuit. The secondary, or high tension circuit, includes the secondary winding of the coil, distributor rotor and cap, high tension wiring, and spark plugs.

IGNITION RELAY

Purpose of ignition relay is to energize ignition circuits only when it is desired to run cooling engine. Refer to figure 4.

When either driver's "Start" or "Test Start" button is pressed, in addition to starter circuit coil of relay is also energized. With relay coil energized, relay points close. Current now flows from "B" terminal across points to "S" terminal. Since "S" and "V" terminals are interconnected, relay is now self-energized - by current flow through its own points. If "Start" button is now released, relay remains energized, and continues to supply current to ignition coil until circuit is broken at master switch or safety switch.

Relay is mounted in back of control panel in air conditioning compartment.

NOTE: If engine starts quickly, then stops, trouble may be due to too rapid release of "Start" button. This occurs especially when battery is low. Hold "Start" button in long enough to assure build-up of magnetic field in relay.

Contact Point Cleaning

Before attempting adjustment of relay, remove cover and make sure contact points are open and clean. Clean contact points with a thin, fine-cut file if pitted or burned.

Air Gap Adjustment

With the contact points closed, measure air gap between the armature and center of core. Adjust air gap by loosening two screws and move armature up or down as required (fig. 17). If necessary, align the support carrying the lower contact so that air gap will be uniform between the core and the armature. Refer to "Specifications" later in this manual for proper air gap.

Point Opening Adjustment

Measure contact point opening with armature in open position. Adjust by bending armature stop (fig. 17). Refer to "Specifications" later in this manual for correct point opening.

Closing Voltage Adjustment

With original leads connected to relay terminals, connect an accurate reading voltmeter at "Vac." and "Gen." terminals in parallel with the circuit. To check closing voltage, insert a variable resistance of 10 ohms (resistance should be capable of carrying 1 ampere) in series in relay circuit from battery. With controlling switch closed, adjust resistance until the relay points close and note voltmeter reading. Adjust by bending armature spring stop to increase or decrease tension on armature (fig. 17). Increasing tension increases closing voltage and decreasing tension decreases closing voltage.

IGNITION COIL

The ignition coil, mounted above flywheel housing, transforms or steps up low voltage to high voltage action of distributor points.

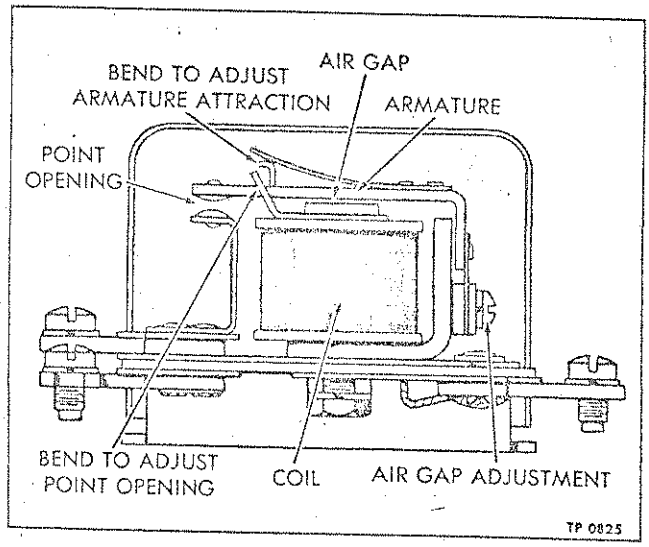


Figure 17—Ignition Relay

As no definite period can be given for ultimate life of an ignition coil, it is recommended that coil be tested with a suitable coil tester at least every six months. If there is any doubt as to the coil's ability, tests should be made regardless of interval.

The ignition coil requires very little maintenance except cleaning of wire terminals and occasional tightening of coil bracket. Use a small, round brush to clean high tension socket. Keep terminals tight and clean.

DISTRIBUTOR

Distributor is mounted horizontally on left side of engine (considering flywheel end as rear of engine). Access to distributor is obtained by entering right-hand intermediate baggage compartment and removing access plate.

Distributor is driven from engine camshaft. Purpose of the distributor is to assist in the induction of primary voltage to secondary voltage, and to distribute the secondary (high) voltage in correct sequence to the spark plugs.

The distributor is equipped with centrifugal advance mechanism.

Cap

Clean each socket with a small round brush. Clean cap inside and out. Inspect for cracks, corroded or burned terminals, and carbonized cracks (evidence of secondary circuit leaks).

Rotor

Inspect for cracks and evidence of burning on the metal strip. If metal strip is burned excessively, replace rotor.

Condenser

The condenser, mounted on inside of distributor and connected across points, reduces distributor point arc by its ability or capacity to store up electrical energy. If condenser is suspected, remove, test with a conventional tester, or replace with one known to be good. After removing cap and rotor, remove screw attaching condenser to breaker plate, then remove pigtail from primary terminal. Position new condenser on breaker plate, then attach with screw and lock washer. Attach pigtail to distributor primary terminal. Tighten all connections snugly.

Points

Distributor point service is one of the most important items in ignition system maintenance. Cleaning of points, replacing when excessively worn or pitted, and proper adjustment of point gap must be accomplished at regular intervals if ignition system is expected to perform efficiently.

IMPORTANT: Points should be inspected and, if necessary, cleaned and adjusted at least every 50 hours of operation.

Point Adjustment

1. Make sure that safety switch is in "OFF" position. Remove distributor cap and rotor. Clean points with a fine-cut file.

2. Turn over engine until breaker arm pad rests on high point of distributor cam. Engine can be turned over by prying against flywheel teeth with screwdriver after removing timing hole cover on flywheel housing.

3. New points can be measured with a feeler gauge; however, correct gap on used points can only be successfully obtained with an angle meter.

4. The correct gap is 0.024." Loosen clamp screw and turn eccentric screw to obtain correct opening.

Point Replacement

1. Remove cap and rotor, then remove condenser pigtail from terminal. Pull up breaker arm to remove, then remove clamp screw to lift contact point plate.

2. Place new contact point plate over eccentric screw, then install clamp screw. Install breaker lever over pivot pin as spring is placed over terminal.

3. Attach condenser pigtail to terminal, and tighten nut.

4. Check the breaker lever spring tension (17 to 21 oz.); bend spring if necessary to obtain correct tension. Adjust points as described above.

IGNITION TIMING

Timing the ignition system comprises, (1) Initial timing -- setting of the distributor mechanism to permit opening of the points at correct firing intervals, and (2) Manual advance - retarding or advancing the point opening to compensate for various grades of fuel which may be used. These timing factors require checking and adjustment at regular intervals.

Automatic Spark Advance

Distributor is equipped with an automatic advance mechanism of the centrifugal control type. This mechanism is mounted on distributor shaft, and consists of counterweights and springs. As engine speed increases, the counterweights act to advance spark to develop maximum power. This control is entirely automatic and requires no adjustment.

At regular inspection periods, a simple check for freeness of operation can be made. Remove distributor cap, rotor, and seal, then rotate cam in the direction it rotates. There should be no binding and cam should return to position when the cam is released. Centrifugal mechanism cannot be repaired unless distributor is disassembled.

Initial Timing

Readjustment of the initial timing is generally

only necessary whenever the distributor has been removed from its mounting; however, periodic checking of the initial timing should be accomplished as a part of routine ignition maintenance.

Following operations are accomplished with engine not running. Make sure safety switch is in "OFF" position.

1. Locate No. 1 spark plug wire on distributor cap, then place a mark on the distributor body opposite No. 1 wire.
2. Clean and adjust, or replace points if necessary. Do not replace cap. Install rotor.
3. Loosen dial screw and set manual advance to "O" mark on dial. Tighten screw firmly.
4. Remove timing hole cover on flywheel housing. Turn engine over by prying against flywheel teeth with a screwdriver until distributor rotor approaches mark previously placed on body.
5. Continue turning engine slowly until mark on flywheel DC/F (Dead Center/Fire) is aligned with marks on opening. A small mirror is required to see these marks with unit mounted in coach.
6. Loosen distributor clamp screw and turn distributor counterclockwise until bumper block clears cam lobe and points close. Then turn distributor clockwise until points barely begin to open. Clamp distributor in this position by firmly tightening clamp screw.
7. Remove distributor rotor, then install seal and gasket, rotor, and distributor cap.

Manual Advance Adjustment

1. Following adjustment should be made with engine operating at high speed (2400 rpm) and under load. High speed is automatically obtained when operated by controls in air conditioning compartment. To insure load on engines it may be necessary to partially block air flow through refrigerant condenser, until it becomes warm.
2. Connect electric tachometer to engine according to manufacturer's directions. Start engine and run until refrigerant condenser warms.
3. Loosen distributor dial screw and turn distributor to position at which tachometer registers highest speed. Lock distributor in this position by tightening dial screw firmly.

IGNITION WIRING

High Tension Wires

The high tension wires in the ignition system consists of the four wires connecting the distributor cap to the spark plug terminals, and the wire connecting the secondary circuit of the ignition coil to the center electrode in the distributor cap. The wire from the ignition coil to the center electrode in the distributor cap carries the high voltage surges from the coil to the distributor. The spark plug wires carry these high voltage surges to the spark plugs as directed by the rotor.

Low Tension Wires

The low tension wires include the wires delivering the current from the source of power (battery or generator) to the ignition coil, and from the ignition coil to the distributor primary terminal.

Inspection and Repair

High and low tension wires require frequent inspection. At regular intervals the wires should be examined for damage. If wires are cracked or swollen, they should be replaced with new parts. Make certain that terminal nuts and connections are clean and tight at all times. Be sure terminal at each end of wire is tight and that cables seat firmly into distributor cap sockets.

SPARK PLUGS

The spark plug is the medium through which the high-tension, or secondary, voltage is converted into a spark in the combustion chamber of the engine to ignite the mixture of air and gasoline. Spark plugs are subjected to severe service during operation and require the same degree of careful inspection and care as do the other units of the ignition system.

Inspection

At regular intervals, spark plugs should be inspected for cracked porcelains, burned points, and point gap. Also check for damaged gaskets and loose terminals. Replace plugs which have excessively burned points or cracked porcelains.

Spark plugs should be cleaned with standard sandblast cleaning equipment or with the use of dry-cleaning solvent.

Setting Gap

Setting spark plug gap is a precision operation and should be treated as such. Proper adjustment provides clearance between side electrode and center electrode. Refer to "Specifications" later in this manual for recommended gap. When regapping is necessary, bend side electrode only. Do not bend center electrode. All plugs must be set to the same dimension, using a standard round feeler gauge.

Installation

1. Use only plugs of proper type and heat-range. Refer to "Specifications" later in this manual.
2. Coat plug threads with grease containing mica to prevent seizure in cylinder head.
3. Always use new gaskets when installing spark plugs. Slide gasket over plug threads and

thread plug into cylinder head with fingers. Be sure gasket does not drop off when positioning plug.

4. Tighten plug until it bottoms on gasket, then turn 1/4 to 1/2 turn to partially compress gasket. Use of ordinary wrenches may crack or otherwise damage plugs. Do not use extreme force in tightening plugs as this would be injurious to gaskets.

5. Make sure the spark plug terminals on the wires are clean and tight. Connect the wire terminal firmly onto spark plug terminal.

GOVERNOR AND THROTTLE

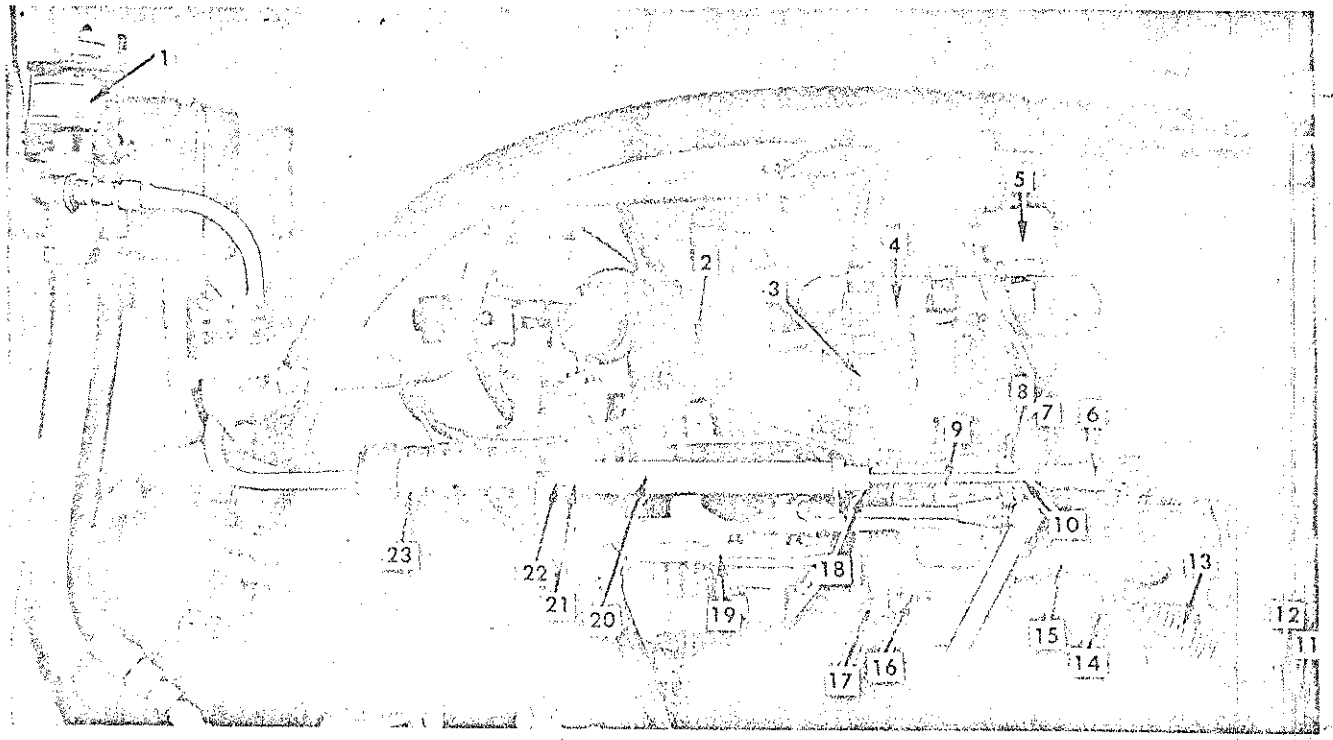
Throttle control mechanism (fig. 18) consists of governor and linkage, low speed spring, high speed spring tube, throttle air cylinder, and magnet valve. Mechanism is controlled by "Engine Modulation" thermostat, which is described in "System Maintenance," earlier in this manual.

THROTTLE CONTROL OPERATION

Linkage is in position shown (fig. 18) as engine is started, assuming that temperature in evaporator compartment is high enough (74°F. approx.) to close throttle thermostat. With thermostat closed, magnet valve is energized and air is exhausted from throttle air cylinder. Carbureter butterfly valve is fully open and link slot is positioned as shown.

High Speed

As engine begins to fire, governor weights tend to close throttle. Movement of governor shifter lever, however, is resisted by combined tension and compression of low speed spring (13, fig. 18) and spring in spring tube (20, fig. 18).



1 Throttle Control Magnet Valve
2 Electric Choke
3 Crankcase Ventilator Valve
4 Engine Intake Manifold
5 Antibackfire Switch
6 Clevis
7 Clevis Lock Nut
8 Throttle Butterfly Valve
9 Carbureter Low Speed Adjustment
10 Throttle Control Rod
11 Low Speed Screw
12 Low Speed Nut
13 Low Speed Spring
14 Governor Buffer Screw
15 Governor Shifter Lever
16 Carbureter
17 Choke Valve
18 High Speed Adjustment
19 Fuel Pump
20 Throttle Control Spring Tube Assembly
21 Push Rod Lock Nut
22 Throttle Control Cylinder Push Rod
23 Throttle Control Cylinder

TP 3748

Figure 18—Engine Throttle Controls

Pin in governor shifter lever (15, fig. 18) remains in outer end of slot in clevis (6, fig. 18). Tendency of governor to close throttle is thus overcome by springs, and engine operates at high speed (2400 rpm).

Low Speed

As temperature in evaporator compartment falls below approximately 74° F., throttle thermostat opens. Exhaust-type magnet valve is de-energized, admitting air pressure to throttle control cylinder (23, fig. 18). Movement of piston in cylinder moves inner end of slot in clevis (6, fig. 18) towards pin in governor shift lever (15, fig. 18).

Relieved of compression of high speed spring in spring tube (20, fig. 18), governor lever moves throttle toward closed position. This action continues until tension of low speed spring balances force exerted by lever. Governor shifter lever pin now floats in slot in clevis (6, fig. 18), as engine operates at low speed (1400 rpm).

ADJUSTMENT

Preliminary adjustment is made with engine not running. Make sure master, test, and safety switches are turned off.

Preliminary Setting

1. Disconnect throttle rod clevis (6, fig. 18) from lever (15, fig. 18) by removing pin.

2. Adjust governor shift lever to carbureter linkage. Throttle lever should move an equal distance above and below horizontal as shift lever is moved over full range. Make sure carbureter stop screw does not contact stop.

3. Loosen lock nut (21, fig. 18) and unscrew spring tube (20, fig. 18) from push rod (22, fig. 18). Reassemble spring tube to push rod, making sure that push rod does not contact end of throttle control rod (10, fig. 18). Tighten lock nut.

4. Loosen lock nut (7, fig. 18) and adjust clevis so that pin is in outer end of slot. Adjustment must provide slight clearance between pin and end of slot. Tighten nut and install pin.

Final Adjustment

1. Connect electric tachometer to engine, following manufacturer's directions. Start engine from air conditioning compartment. For accurate adjustment, engine must be warm and under load (refrigerant condenser warm). If necessary, partially block air flow through condenser.

2. Run engine at slow speed by wedging small screwdriver above magnet valve armature to hold armature down. Use care to avoid damaging magnet valve. Adjust carbureter low speed screw (9, fig. 18) for best operation.

3. Adjust engine speed to 1400 rpm by turning low speed nut (12, fig. 18).

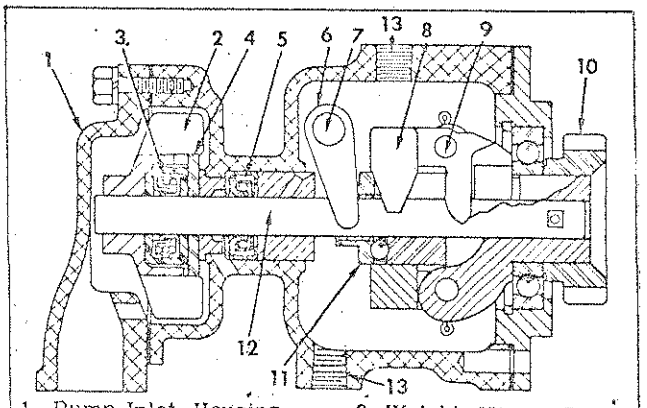
4. Remove screwdriver from magnet valve, to permit engine to operate at high speed. Adjust engine speed to 2400 rpm by loosening lock nut and turning adjustment (18, fig. 18). Tighten lock nut when proper speed is obtained.

GOVERNOR

Governor is conventional movable weight type, driven, with water pump, from engine timing gear (fig. 19). Centrifugal force causes weights to fly outward as engine speed is increased. This action moves ball thrust bearing which turns shifter lever.

Governor is non-adjustable, except for buffer screw, but care must be taken to see that correct governor weights and levers are used. Lubrication is automatically supplied by engine oiling system.

Buffer screw (14, fig. 18) is used only to stop hunting or surging. Screw should be turned in only enough to stop hunting, but should never be turned in far enough to appreciably increase engine speed.



1 Pump Inlet Housing
2 Water Pump Impeller
3 Water Pump Seal
4 Carbon Thrust Washer
5 Shaft Oil Seal
6 Gov. Shifter Lever
7 Shifter Lever Shaft
8 Governor Weight
9 Weight Hinge Pin
10 Governor and Water Pump Drive Gear
11 Governor Shifter Thrust Bearing
12 Governor and Water Pump Shaft
13 Oil Line Connections

TP 3751

Figure 19—Sectional View of Governor and Water Pump

MAGNET VALVE

Exhaust type magnet valve is mounted on bulkhead of air conditioning compartment (1, fig. 18). Magnet valve directly controls speed of engine by admitting air pressure to (or by exhausting pressure from) throttle control valve. Valve is automatically operated by "Engine Modulation" thermostat in evaporator compartment, and is directly energized by test switch.

De-energized magnet valve permits air pressure to flow from outlet (fig. 20) to throttle cylinder. When energized, passage from inlet is

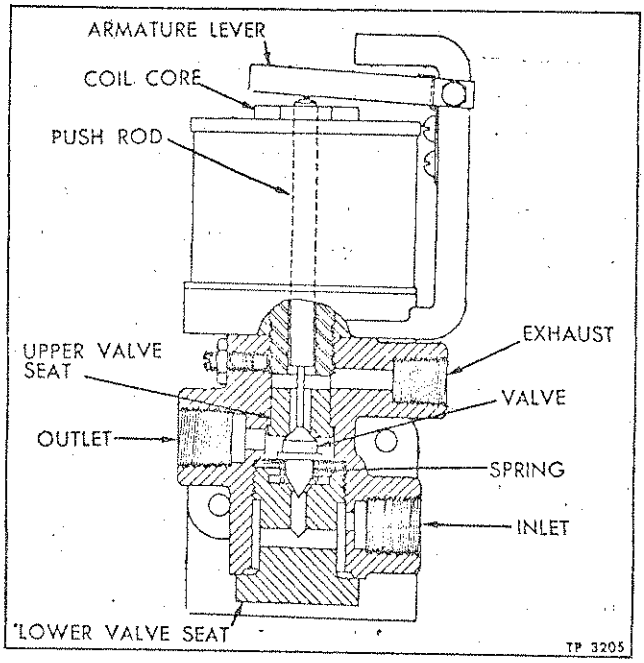


Figure 20—Throttle Control Magnet Valve

closed, while upper valve is unseated, exhausting air from throttle cylinder.

Magnet valve may be tested for leakage with air pressure gauge, or with soap and water solution. With valve de-energized, no pressure should be obtained at exhaust connection. With valve energized, or with armature lever depressed manually, no indication of pressure should be obtained at outlet connection.

Valve Grinding

If tests disclose leakage valve may be disassembled and cleaned. When inspection shows necessity, valves may be ground, as follows:

Unscrew lower valve seat from magnet valve, and remove valve spring and valve. Position lower end of valve in valve holder C-21290, then push valve holder part way through C-13622 guide. Apply a small quantity of fine grinding compound to upper face of valve, then position holder, guide, and valve in bottom of magnet valve. Rotate end of projecting valve holder until all scores disappear from upper face of valve.

To grind lower face of valve, remove armature lever, push rod, lower valve seat, spring, and valve from magnet valve. Apply a small quantity of valve grinding compound to lower face of valve. Install valve, valve spring, and lower valve seat in magnet valve. Insert valve holder C-21300 through hole in coil core from top of magnet valve. Turn valve holder slowly until slotted end of holder fits over stem of valve. Rotate valve with holder until valve face is smooth,

After either valve has been ground, wash valve faces thoroughly in gasoline. Blow out all passages in magnet valve with compressed air to remove all traces of grinding compound.

When assembling magnet valve, make sure push rod projects 1/16 inch above top face of coil core. Gauge C-14022 may be used to insure correct adjustment.

Install new push rod if rod projects less than 1/16 inch. New push rods are longer than required and must be filed or ground to proper length.

Correct air gap between armature and top of coil core, with armature depressed, is 0.032" to 0.042."

IMPORTANT: Push rod length and air gap must be held to dimensions given to insure satisfactory operation of valve. Armature may become magnetized and fail to release if push rod is too short. If rod is too long, armature may not be attracted to core when battery is low.

THROTTLE CONTROL CYLINDER

Throttle control cylinder is mounted on bracket attached to engine as shown in figure 18. Movement of piston is limited by an internal stop. Cylinder contains a compression spring which returns piston to retracted position when air pressure is cut off.

Cylinder should operate indefinitely without attention, other than monthly cleaning of breather valve in side of cylinder. Piston cup can be replaced, being accessible after unscrewing end cap. Whenever cylinder is disassembled, lubricate piston cup sparingly with chassis grease.

IMPORTANT: When replacing piston cup, use care to avoid distorting cup by overtightening nut. Tighten nut only finger tight, secure with cotter pin, and bend pin down.

FUEL SYSTEM

Fuel system consists of fuel tank and lines, electric fuel valve, fuel pump, carburetor, and electric choke. Schematic diagram of fuel system is shown in figure 21.

Fuel Tank

Fuel tank is mounted in left side of coach at rear of rear wheelhouse. Filler neck is accessible through filler door in side of coach. CAUTION: Use only gasoline - do not add Diesel fuel to this tank.

Tank should be cleaned periodically. Fill tank at end of day's run to reduce condensation of moisture from air in tank during storage. NOTE: Many states will allow deduction of gasoline road tax for fuel used in this tank.

Fuel Lines

Return fuel system is employed to provide

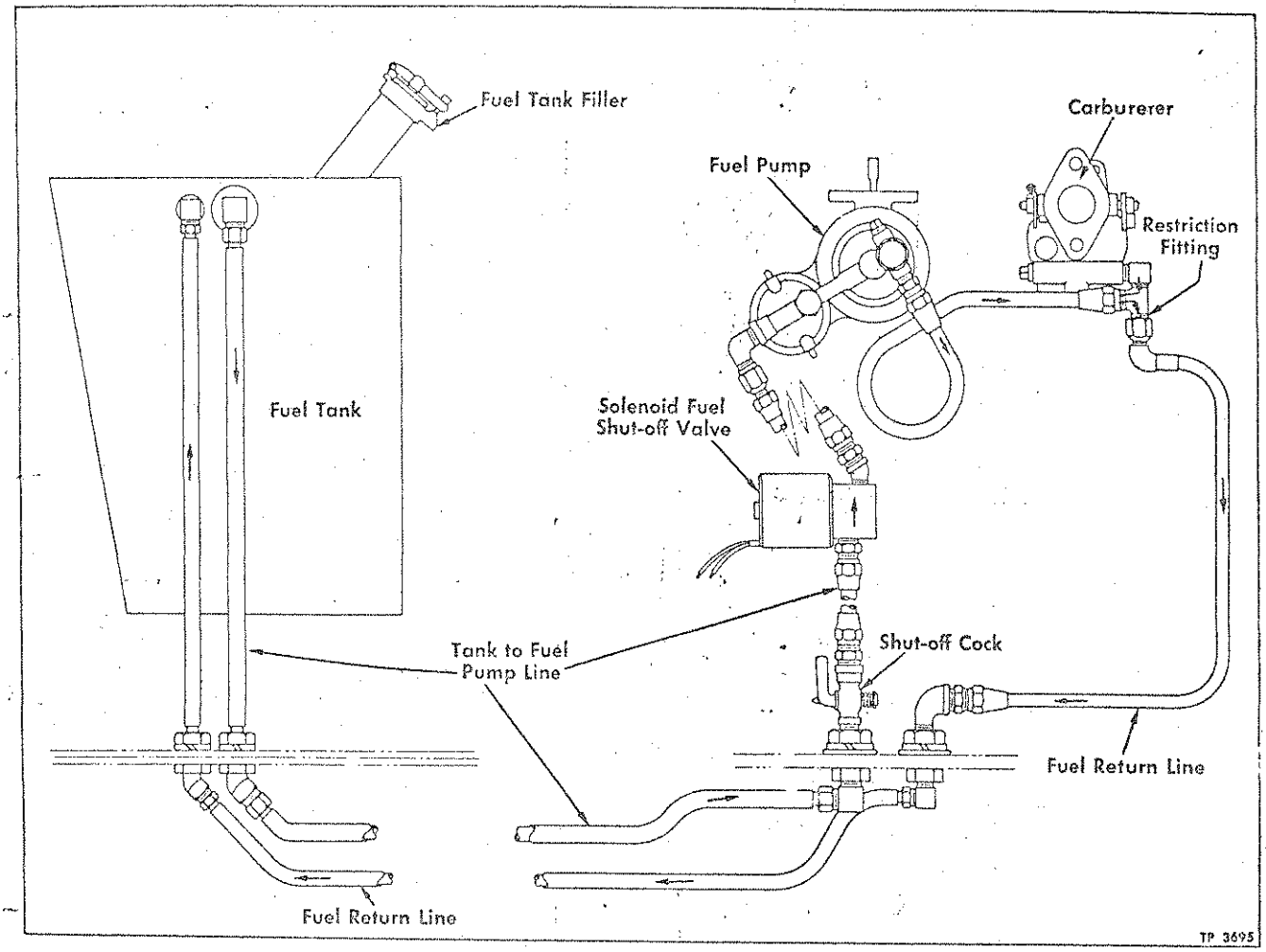


Figure 21—Fuel System Diagram

adequate supply of fuel to carbureter without excessive pressure. This system also reduces possibility of vapor lock since larger flow of fluid acts to cool lines. Fuel feed line incorporates a manual shut-off cock near engine. Cock should be turned off in event of failure of electric fuel valve. Valve should always be closed when air conditioning unit is removed from coach, and both feed and return line connections should be capped.

ELECTRIC FUEL VALVE

Fuel shut-off valve of solenoid type is connected in fuel feed line between manual shut-off cock and fuel pump. Valve is mounted back of engine air cleaner, near refrigerant receiver.

Valve is normally closed, opening when electrically energized by ignition circuit to which it is connected.

Function of valve is to shut off flow of fuel to carbureter except when engine is running. Level of fuel in a full tank is higher than carbureter. If carbureter float valve should leak, a siphoning action would occur which would empty tank of fuel. Consequently, electric fuel valve is used to prevent this action.

Maintenance

Valve requires no special maintenance, however, valve should be tested for leakage at engine overhaul. Valve is tested by blowing through valve port stamped "IN." If leakage is detected, unit may be disassembled and valve ground. Failure of valve to open necessitates replacement of unit.

FUEL PUMP

Fuel pump (fig. 22) is diaphragm type (AC-Type W) and is mechanically operated from an eccentric on camshaft. Diaphragm is composed of several layers of specially treated cloth which is impervious to gasoline. This cloth material, held between two metal discs, is pushed upward by a pump spring, and pulled downward by linkage to camshaft. Diaphragm in its downward movement, causes a vacuum in pump chamber and fuel

is drawn through glass bowl and strainer to fill this vacuum. Upward movement of diaphragm forces fuel through line leading to carbureter.

Repeated movement of diaphragm is possible indefinitely without injury, due to extreme flexibility of this material. Movement of diaphragm occurs only when carbureter needs fuel. When carbureter needs fuel, movement of diaphragm is directly proportional to amount of gasoline used by the engine. This means that in practically all normal operating conditions, diaphragm is pulsating in movement of a few thousandths of an inch.

Movement of diaphragm is controlled by linkage. When diaphragm is in depressed position due to sufficient fuel in carbureter, up and down movement of fuel pump link ceases and rocker arm spring keeps rocker arm in contact with eccentric on camshaft.

Maintenance on Vehicle

Glass bowl and filter screen should be removed and cleaned frequently to avoid excessive accumulation of water and dirt.

Knurled nut at glass bowl should be kept tight to prevent leaks. All connections should be inspected and tightened when necessary.

Testing Fuel Pump

In order to obtain fuel economy, it is important to test fuel pump to determine whether or not it is giving enough yield to insure sufficient fuel flowing to carbureter at all times, also to determine if fuel pump may be exerting an overpressure.

These tests (static pressure and capacity bleed tests) are separate and distinct from each other and must be made with pump mounted on engine. Tests can be made before pump is overhauled to determine condition of unit. Tests should also be made after pump is overhauled to test performance.

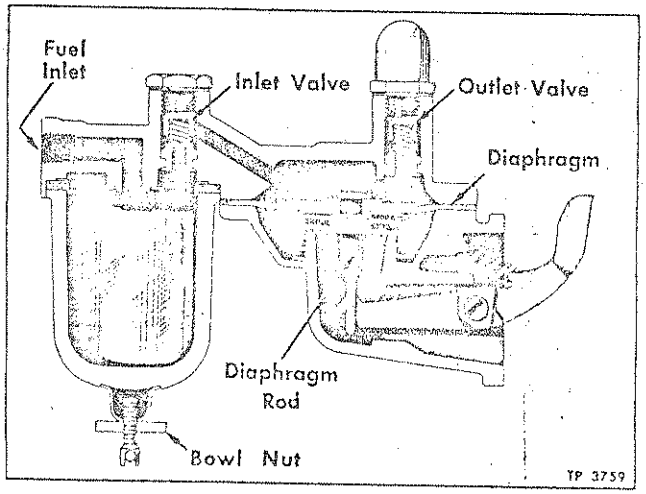


Figure 22—Fuel Pump

When testing fuel pump, static pressure test should be made first to determine whether or not fuel pump is creating an overpressure. Pump creating an over-pressure requires removal for replacement or repair. NOTE: The capacity bleed test need only be made if the static pressure test is within "Specifications" shown at end of this section.

Static Pressure Test

1. Disconnect carbureter line at fuel pump.
2. Install necessary adapter and tee fitting in pump outlet and attach the pressure gauge with rubber tubing.
3. Close remaining tee opening and run engine at low speed (1400 rpm) on fuel remaining in carbureter. Less than one minute's operation of the engine should be sufficient for this test.
4. Reading on gauge is the static pressure of the fuel pump and this reading should be listed in "Specifications" in this section.

Capacity Test

Capacity test is designed to measure the amount of liquid fuel which the pump will deliver in excess of fuel needed to operate the engine at an idle speed. Adequate fuel delivery is available when a full pint flows in proper time limit shown in "Specifications" in this section. If less fuel flows in time allotted, generally an air leak exists in the intake fuel line. This leak may be located at any point in the line from the fuel tank to the fuel strainer bowl of the fuel pump.

To make the capacity test, insert a tee fitting in carbureter inlet. Attach the fuel line to the tee, start the engine and note time necessary to fill a pint measure with fuel from remaining outlet of tee.

As long as above tests do not show a pressure over maximum shown in "Specifications," but give at least minimum flow in capacity, or second test, efficient engine operation from standpoint of fuel pump is assured.

CARBURETER

Up-draft type carbureter, shown sectionally in figure 23, is mounted on right side of engine. Air is supplied to lower part of carbureter through hose and tube from air cleaner.

Operation

Key Numbers Refer to Fig. 23.

All air entering carbureter must pass through air cleaner which excludes practically all dirt and foreign matter.

Venturi (2) increases air stream at jet, while volume of air is controlled by throttle plate (1).

Fuel enters carbureter through float valve (9). Since fuel-air ratio is influenced by level of fuel, float closes float valve when level is at desired

height. As fuel flows through jets, fuel level falls and float opens valve, permitting entry of additional fuel.

Main jet (5) is often called "high speed jet" because its greatest influence is exerted at higher engine speeds. It is a direct suction jet, discharging fuel through discharge jet (3) into air stream at venturi (2).

Compensating system consists of main discharge jet (3) and well vent (7). Flow of fuel from main jet (5) is controlled by size of well vent (7) and main discharge jet (3).

Idling system consists of idling jet (10) which measures fuel, and idle adjustment (11) which regulates air. Idling jet (10) receives fuel from main discharge jet (3) through channel (6). Fuel, metered through idling jet (10), is mixed with air obtained from behind venturi (2).

Idling system functions only at idling and low speeds. At low speeds, with throttle nearly closed, a strong suction exists past edge of throttle plate (1). This strong suction draws mixture of fuel and air from idling jet (10), discharging mixture through priming plug (12).

Adjustments

All mixture adjustments, other than idling, are determined by calibration of jets and can only be changed by disassembling carbureter and installing different jets. Sizes of jets should not be changed unless recommended by factory service department. When replacing parts, use parts stamped with same number as parts which were removed.

Adjust idling mixture as described in "Governor and Throttle," earlier in this section.

Fuel Level

Fuel level may be checked by removing carbureter and disassembling throttle body from bowl. Inspect float valve and replace, if necessary.

Invert throttle body and make sure float valve is seated. Move gasket to one side. Measure from gasket surface of throttle body to top of float. Dimension should be 1-5/32", plus or minus 3/64". Bend float arm as necessary to obtain this dimension.

Carbureter Inspection

Carbureter should be removed, disassembled, and thoroughly cleaned at engine overhaul (approx. 500 hours of operation). Blow out all passages thoroughly. When carbureter is reassembled use only new gaskets throughout.

ELECTRIC CHOKE

Choke, mounted on right side of engine, is an electric choke - not an automatic choke. Choke is controlled only by "CHOKE" button on control panel at driver's left, but may be manually operated when starting engine from air conditioning compartment. Choke operation is not affected by engine manifold vacuum or by engine temperature.

Adjustment

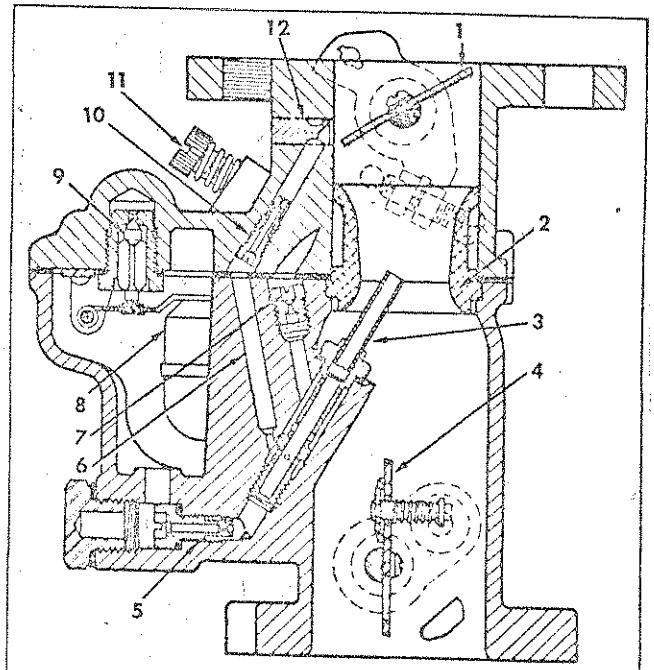
Electric choke (2, fig. 18) is connected to carbureter choke valve by an adjustable link. Length of link is adjusted by removing pin from carbureter choke lever then turning clevis. Adjust link so that carbureter choke is wide open with electric choke lever raised to top limit.

AIR INTAKE SYSTEM

Air intake system consists of air cleaner, intake hose, intake pipe, and drain check valve (fig. 24). All air for combustion in engine passes through air cleaner, and is then conveyed to carbureter through hose and tube. Since engine produces a suction, leakage at any point will permit unfiltered air to enter engine. Keeping hose clamps and connections tight is an important part of engine maintenance.

AIR CLEANER

Air cleaner is oil bath type, which requires regular inspection and servicing.



1 Throttle Plate
2 Venturi
3 Main Discharge Jet
4 Choke Valve
5 Main Jet
6 Channel
7 Well Vent
8 Float
9 Float Valve
10 Idling Jet
11 Idle Adjustment
12 Priming Plug

TP 3753

Figure 23—Carburetor

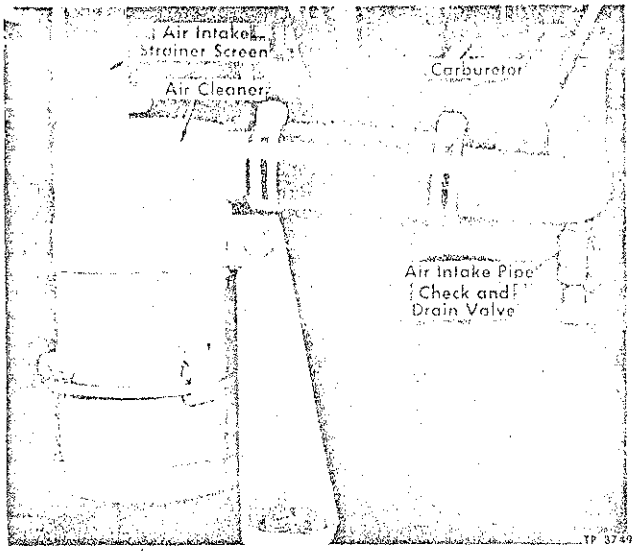


Figure 24—Air Intake System

Air enters intake screen on top of cleaner then passes downward through tube to bottom of cleaner. Air inlet is submerged in oil and maintains a vortex action in cleaner. Design of edges prevent uncovering air inlets at low oil levels.

Maintenance

Air cleaner should be serviced whenever engine oil is changed. Cleaner should also be inspected frequently and serviced when oil thickens or if reservoir is one-third full of sediment.

To service cleaner, disengage two latches and remove bottom cup. With fingers dislodge and remove disc-shaped pre-filter from cleaner. Other filter element in top of cleaner serves as oil eliminator and need not be cleaned or replaced. Wash pre-cleaner and cup in gasoline to remove all foreign matter. Install pre-filter in cleaner. Fill cup to mark with engine oil, S.A.E. 20. Position cup to cleaner and secure latches.

DRAIN CHECK VALVE

Valve is disc-type check valve with breather. Valve is mounted in bottom of air intake pipe and serves to drain excess fuel from flooding carbureter, with engine not running. With engine running, suction in manifold seats valve to prevent entry of dirty air. IMPORTANT: Valve must be maintained in working order to prevent rapid wear of engine parts. If valve does not close, abrasive particles in unfiltered air will be drawn into engine.

Maintenance

Valve should be checked and cleaned frequently. Unscrew valve from intake pipe. Hold valve vertically, with breather down, and apply suction to upper end. If vacuum cannot be maintained, unscrew valve plug from body. Examine disc and seat in body. Clean parts thoroughly.

IMPORTANT: Valve disc must not be cocked in valve body when assembling. Hold valve body vertically. Position seat in disc, making sure disc lies flat. Screw plug into body, and tighten firmly.

COOLING SYSTEM

Engine cooling system is illustrated in figure 25. System consists of engine water pump, radiator, surge tank, thermostat, and blowers. Instead of conventional-type fan, two sirocco-type blowers are used to circulate air through radiator, in connection with refrigerant condenser.

CIRCULATION

Water pump, driven by engine timing gear circulates coolant from radiator through engine water passages, then back to radiator where it is cooled by action of blowers (fig. 25). Thermostat, mounted in engine water outlet, restricts flow of water to radiator until a pre-determined temperature is reached. Thus, time required to reach an efficient operating temperature is minimized.

INSPECTION OF SYSTEM

Since action of cooling system controls operating temperature of engine, it is logical to assume that cause of overheated engine lies in cooling system: however, late ignition timing or improper or insufficient lubricating oil in engine crankcase will cause engine to overheat, even though cooling system is functioning properly.

Systematic periodic inspection of units in cooling system is essential to maintain efficiency of system. Inspect at regular intervals as follows:

1. Check water in radiator. Keep radiator filled to proper level. Check antifreeze solution if used.

2. Rust-proof cooling system twice a year. Use a good chemically treated antifreeze in the fall and a special rust preventive (inhibitor) with a fresh filling of clean water and inhibitor in the spring.

3. Check condition of all hose connections. Tighten clamps if necessary. Cracked or swollen hose connections should be replaced with new hose.

4. Check radiator core for leaks. Make certain that core is not clogged with dirt or insects. Clean out with air hose, using low air pressure.

5. Inspect water pump operation. A leaky water pump sucks in air, which increases corrosion.

6. Repair all leaks in system. One drop of solution lost each ten seconds amounts to nearly one gallon in a week. Always keep system tight.

7. Test and replace thermostat if necessary.

DRAINING SYSTEM

Single drain cock, located in bottom of radiator, drains entire system. Drain cock is accessible by removing bolts and swinging refrigerant condenser outward, as described earlier in this manual.

FILLING SYSTEM

Filler cap is located in left side of coach, and is accessible after opening door in side of coach immediately forward of emergency door.

Vehicle should be standing on fairly level ground before starting to fill radiator. If system is empty, fill radiator until liquid can be seen through filler neck.

If the system is filled with cold liquid, thermostat will close even though the engine is warm. This action may trap air in cylinder block and head. Trapped air will leak through thermostat vent hole, thereby lowering liquid level in radiator. Additional coolant should then be slowly added until no further air bubbles are noticed. To further assure that all air has been removed from cooling system, engine should be run a few minutes. If level drops, add more coolant. This method should be used if more than one quart is necessary to refill radiator. Always fill radiator until liquid is visible through neck.

Do not overfill radiator when antifreeze solution is being used, since normal expansion of heated water causes level in radiator to rise and an appreciable amount of liquid will be lost through overflow pipe. When engine stops and solution cools off, contraction of liquid lowers water level, and it is this apparent low level that might give the impression that additional water is needed.

Should water be lost from cooling system, and engine becomes overheated, do not add water immediately - wait until boiling has ceased and engine cooled down. Then add water slowly after starting engine.

CAUTION: Cold water should never be poured into cooling system when engine is hot, as sudden change in temperature may cause a cracked cylinder head.

After system is filled be sure to install cap on filler.

Alkaline Water

In certain areas most available water is alkaline. Alkali readily attacks aluminum, of which cylinder block and head are made. Water which is considerably alkaline, should not be used. Instead, if possible, use distilled water, filtered rain water, or water from a commercial or domestic water softener.

CLEANING SYSTEM

Unless water in cooling system is treated with a corrosion preventive, rust and scale may eventually clog water passages in radiator and water jackets. This condition is aggravated in some localities by the formation of insoluble salts from water used.

Cleaning solutions, commercially available, will successfully clean cooling systems of rust, scale, sludge and grease, when used as directed by the manufacturers. However, if radiator is clogged with insoluble scale formations, reliable

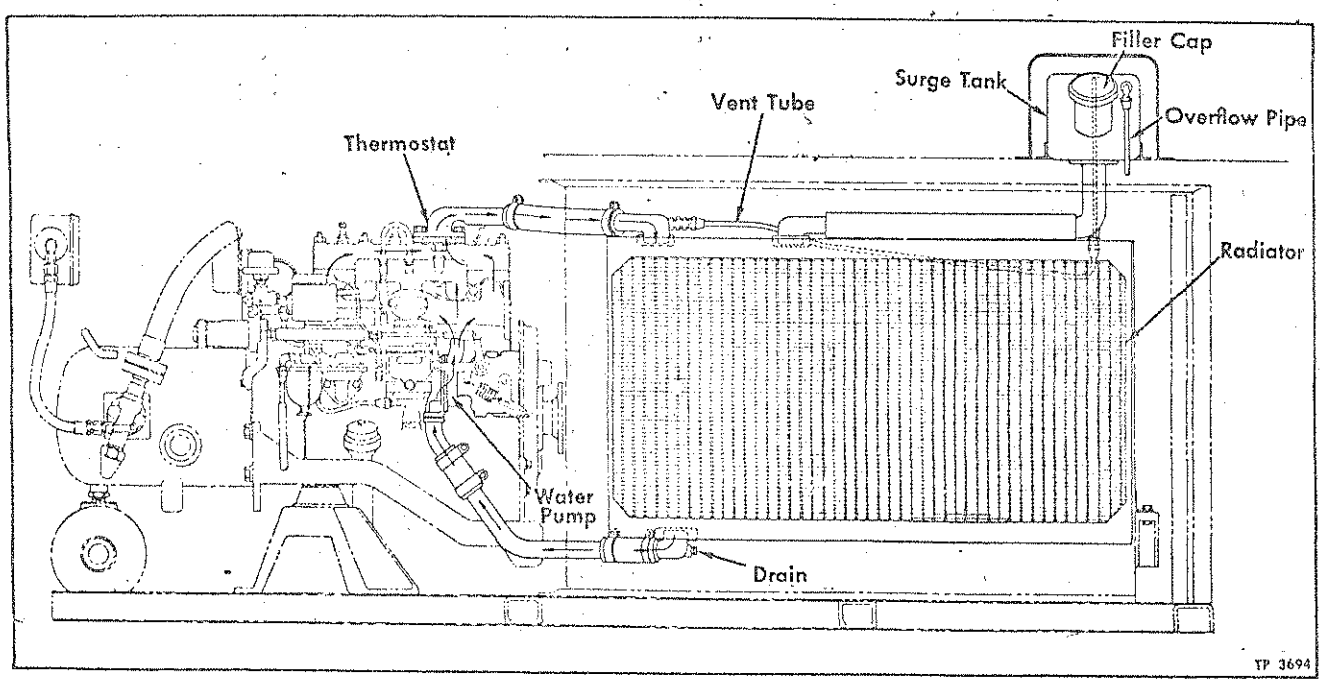


Figure 25—Engine Cooling System

radiator service stations in the various localities are best equipped to remove such formations. These service stations should be familiar with local conditions and in a position to apply proper treatment.

Radiator and entire system should be cleaned, as follows:

Cleaning

1. Drain system, then close drain cock on radiator. Place a container under overflow tube.
2. Fill system with cleaning solution. Always follow manufacturer's directions.
3. With radiator covered and surge tank cap on tight, run engine 15 or 20 minutes. Drain system completely.
4. If cleaning solution used requires a neutralizer, use as directed by manufacturer.

Flushing

1. Before pressure flushing the system, tighten cylinder head bolts to prevent possible water leaks into cylinders and crankcase. Always remove the thermostat.
2. When reverse flushing, apply air gradually, as a clogged radiator will stand only a limited pressure.

Inspection After Cleaning

1. Check all hose connections and thermostat.
2. Flush out surge tank and blow out overflow pipe.
3. Blow insects and dust from radiator air passages and radiator grille.

CORROSION PREVENTION

Water not only causes rust in cooling system, which interferes with circulation and cooling, but also corrosion damage to metal parts, such as cylinder heads, radiator cores and water pump parts.

Two other common causes of corrosion are:

1. Air Suction - Air may be drawn into system due to low liquid level in the radiator, leaky water pump or loose fitting hose connections.
2. Exhaust Gas Leakage - Exhaust gas may be blown into the cooling system past the cylinder head gasket or through cracks in the cylinder head and block.

Treatment of cooling systems, for the prevention of scale and rust formation, has become an accepted automotive maintenance practice. This process consists of introducing into cooling system substances called "Inhibitors" which reduce or prevent corrosion of metals and deposition of scale, thus tending to maintain high cooling efficiency.

In general, inhibitors are not cleaners, and will not remove scale and rust already formed. Inhibitors should be used continuously, preferably immediately after system has been thoroughly cleaned or when vehicle is new.

However, use of additional rust preventives or inhibitors is not recommended with "GM" or other antifreeze preparations already containing an inhibitor, as an excessive amount may be harmful to rubber parts.

Following are the salient points concerning recommended inhibitors:

1. Soluble Oil

Use only in plain water and in antifreeze solutions which do not already contain an inhibitor, and in accordance with instructions issued by the soluble oil manufacturers. Supply stations have available various oil inhibitors. They are marketed under different names but their characteristics are similar.

When using soluble oil in plain water, or in uninhibited alcohol or methanol solutions, do not add too much. Soluble oil is not all lost by evaporation and excessive amounts are undesirable. The amount of soluble oil in a cooling system should never exceed 1% of the volume of the system.

2. Potassium Bichromate

Use only in plain water in proportion of two ounces of crystals to each five gallons of water. Potassium bichromate (dichromate) may be purchased from any drug or chemical house, or under a trade name at supply stations.

COLD WEATHER OPERATION

Water, with an inhibitor, can be safely used as a cooling medium in climates where temperatures do not reach below 32°F. In lower temperatures, antifreeze solutions must be used.

Before installing antifreeze solutions, cooling system should be inspected and serviced for winter, as previously described under "Cleaning System" in this section.

Cylinder head gaskets should be tightened or replaced if necessary, to avoid possibility of antifreeze solution leaking into engine, and exhaust gases entering cooling system.

After antifreeze solution has been installed, entire system should be inspected regularly for leaks.

Thawing Cooling System

If cooling medium in system becomes frozen solid, place vehicle in warm place until ice is completely thawed out. Under No Circumstances Should Engine Be Run When Cooling System Is Frozen Solid.

Antifreeze Solutions

Following information will assist in selecting antifreeze solution best suited to meet individual driving conditions.

The most commonly used commercial materials are:

Denatured (Ethyl) Alcohol
Methanol (Methyl or Wood Alcohol)
Propanol
Ethylene Glycol

Kerosene or other oils, or solutions containing calcium chloride, magnesium chloride, sodium silicate or other inorganic salts, honey, glucose or sugar are not satisfactory for use in cooling system. Care should be taken in selecting an antifreeze solution.

RADIATOR

Radiator is conventional fin and tube construction, mounted back of refrigerant condenser. Water in core tubes transfers heat to fins, where heat is removed by air drawn through core by blowers.

Radiator should be cleaned, by blowing with compressed air, whenever refrigerant condenser is cleaned. At engine overhaul, remove radiator and clean inside and out in cleaning solution. At the same time examine core for leaks and bent fins, and repair if necessary. If radiator core requires painting, spray with special radiator paint; do not use paint mixed with oil as this type of paint will form an insulation on core and prevent dissipation of heat.

A damaged or clogged radiator should be taken to a radiator repair expert or replaced with a new one. Efficient repair of damaged radiator requires use of special tools and equipment, as well as making proper tests.

SURGE TANK

Surge tank, mounted above upper rear corner of air conditioning compartment, permits expansion of coolant without loss from overflow. Excess liquid or vapor in cooling system is exhausted through overflow tube. Surge tank is connected to radiator by means of a hose. Vent tube connects radiator inlet to surge tank to prevent air pockets in radiator inlet line (fig. 25).

THERMOSTAT

Thermostat contained in thermostat housing consists of a restriction valve actuated by a thermostatic element. Entire assembly is installed in housing at cylinder head water outlet above water pump.

Thermostat valve cracks or just starts to open at a predetermined temperature and continues to open in gradual stages as engine temperature reaches a higher degree, determined by the setting of the element. Opening and closing temperatures are given in "Specifications" at end of this section.

The thermostat is a delicately constructed instrument and should be handled accordingly. If thermostat is not functioning properly, remove assembly and see if bellows and valve are in good condition. If they are, test assembly in water, gradually brought up to operating temperature by heating, and then in water at fully closed temperature. Bellows should be completely submerged and water agitated thoroughly when taking temperature readings. Do not attempt to repair thermostat. If it does not function properly, install a new thermostat which has been checked as directed above. Use new gaskets between water outlet and cylinder head.

CRANKCASE BREATHER

Oil bath type air cleaner, mounted on left side of engine, removes dust and dirt particles from air which is used to ventilate crankcase. Cleaner requires the same attention and maintenance as carbureter air cleaner; namely disassembly, cleaning, and filling with new oil to proper oil level, and assembling whenever carbureter air cleaner is serviced. Correct grade of oil and correct oil level must be maintained at all times.

CLEANING BREATHER

1. Remove nut, then withdraw shell and element.
2. Remove element from shell and wash in a suitable cleaning solvent.
3. Allow filter element to drain. Do not blow dry with compressed air.
4. Clean shell oil reservoir thoroughly by washing in suitable cleaning solvent.
5. Fill shell to "Oil Level" with light engine oil (S.A.E. 20) then replace element in shell and install filter.

CRANKCASE VENTILATOR VALVE

The ventilation of the crankcase (removal of fuel and water vapors within the crankcase) is accomplished by the circulation of air, actuated by vacuum. Air is drawn into the crankcase through breather filter. After circulating through the engine, the air is drawn upward and out of the engine. The manifold vacuum tube, connecting to a fitting at the center of the intake manifold, contains a spring loaded plunger type valve which acts as a restriction for vapor flow (fig. 26).

The valve is a positive action type with a stainless steel spring and float valve. Since the valve is located on the outlet side of the crankcase, the flow through the valve into the intake manifold is the sum of piston blowby plus the fresh air entering through the crankcase breather.

The spring works in opposition to the manifold vacuum. At engine idle the valve is closed and the small bleed hole allows the maximum flow without upsetting the carbureter idle. The valve remains closed until the manifold vacuum decreases as the engine speed increases. At higher engine speeds more ventilation is needed so the valve opens to permit a greater flow.

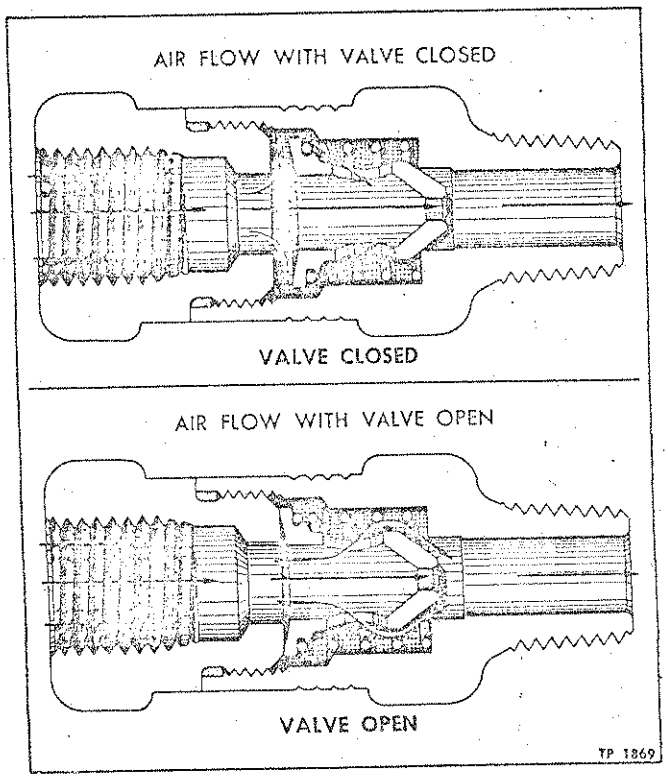


Figure 26—Crankcase Ventilator Valve

MAINTENANCE

At regular intervals, the tube and restriction valve should be removed and thoroughly cleaned. The breather, which cleans the air, requires more frequent attention. Breather is an oil bath type which should be serviced at the same intervals as carbureter air cleaner.

Whenever ventilator valve is disassembled, thoroughly clean all parts in a suitable solvent and blow dry with compressed air. Be sure each orifice in valve is clean. Remove ventilator tube and clean it thoroughly in a suitable solvent, then blow dry with compressed air. Measure free length of ventilator valve spring. Free length is approximately 9/16"; if less or more install new spring. NOTE: To avoid stretching spring, always clean valve and spring as a unit. When reinstalling new spring, make certain that spring seats over ridge of valve.

CAUTION: Regular servicing of breather and ventilator valve is of utmost importance. If both are permitted to become clogged, damage to engine oil seals will likely occur.

OIL FILTER

Oil filter is provided with a removable filtering element which should be discarded and replaced with a new element at periodic intervals. Oil filter is so designed that it will effectively deter contamination of engine oil if given proper maintenance.

MAINTENANCE

The most positive assurance of a continuous and efficient functioning of oil filter is inspection and replacement of filtering element at regular intervals. The filtering element changing periods are directly related to oil changing periods; type and quality of oil used, severity of and type of engine operation. Therefore it is impossible to recommend a definite period that will meet all types of service, other than the recommendation in "Lubrication and Inspection" section of this manual.

In view of the foregoing, it is recommended that frequent inspections be made of engine oil to determine advisable intervals between engine oil and oil filter element changes. In some types of service where operating conditions are severe, laboratory tests, conducted by the oil supplier or by another suitable laboratory of oil drained from engine may be helpful in determining greatest advisable intervals between engine oil and oil filter element changes for a specific operation.

Use only genuine element when replacement is necessary. It is recommended that new cover gasket always be replaced when element is replaced.

Solid matter and water settle to lower portion of filter, and should be drained at regular intervals by removing drain plug. If filter is drained completely, as when element is renewed, add sufficient oil to crankcase to bring oil to correct level.

While oil filter will adequately remove dust and dirt from oil the element must be removed before becoming clogged. Vehicles operating in dusty areas require renewals more often than those which do not encounter such condition.

Removal of Filter Element

Before taking off filter cover, remove plug in filter base, allowing oil to drain from filter. Remove cover nut and lift cover gasket and spring from body. Withdraw element by sliding it over stud.

STARTING SYSTEM

Starting system includes start buttons, anti-backfire switch, startix, starting motor, and wiring. Schematic wiring diagram of system is shown in figure 27.

STARTING MOTOR

Starting motor, mounted on left side of engine, is 12-volt type, with Bendix drive. Starter pinion engagement with flywheel gear teeth is conventional.

Normal service may be obtained from starter with a minimum of trouble if regular lubrication,

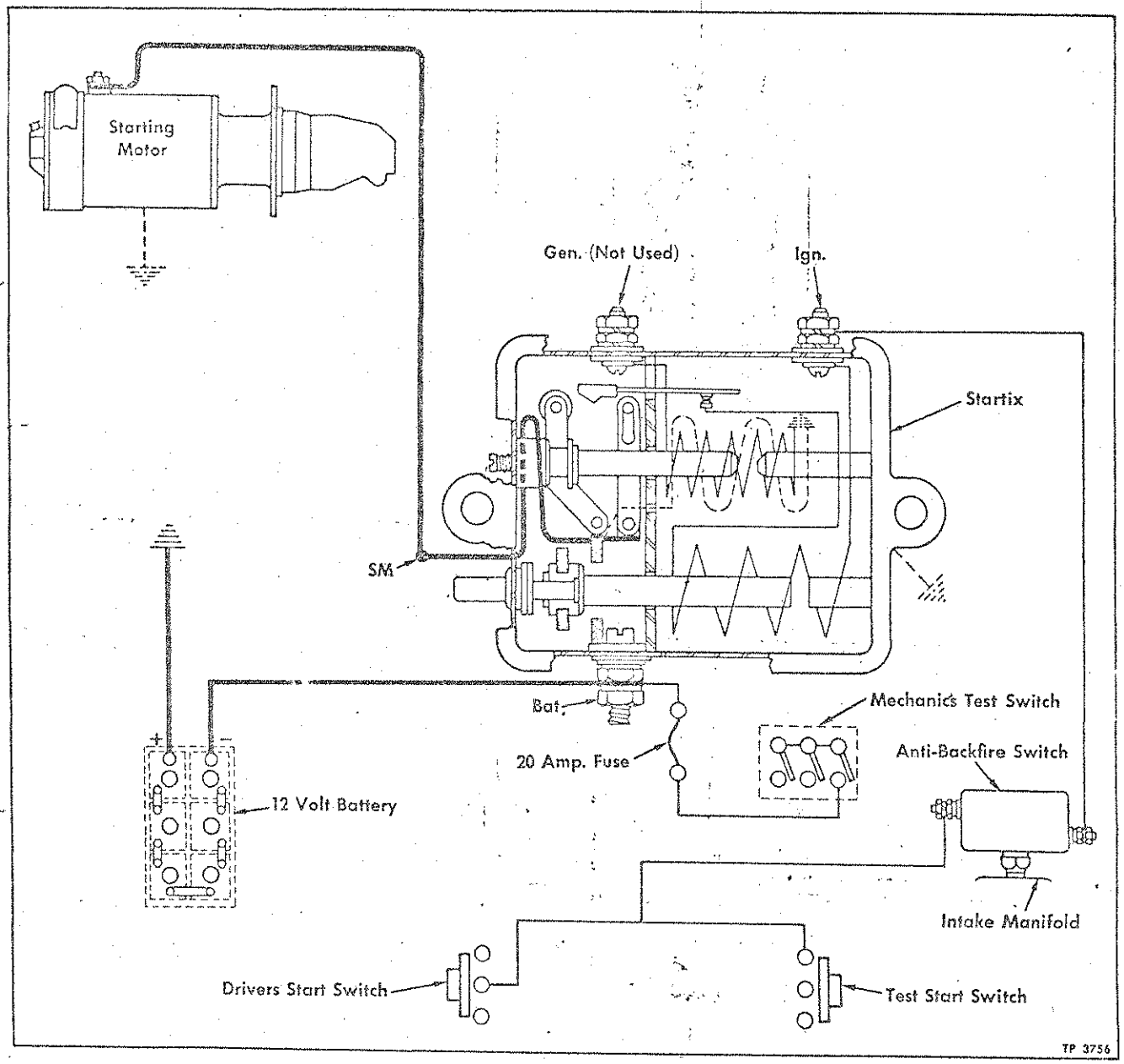


Figure 27—Startix Wiring

inspection, and maintenance procedures are followed. Refer to "Lubrication and Inspection" section of this manual for lubrication intervals.

Cleaning

Exterior as well as the interior of the starter should be kept clean. Use a clean cloth dampened with cleaning solvent to wipe off excess grease. Do not steam clean or dip starter, and avoid getting any water or cleaner in the starter. If interior of starter is dirty, it should be removed, disassembled, and all parts cleaned.

Commutator

The cover band should be removed and commutator inspected at 5000 mile intervals. If commutator is dirty, clean with a strip of No. 00 sandpaper. DO NOT USE EMERY CLOTH. All dust must be blown from starter after commutator has been cleaned.

Brushes

Replace worn brushes. New brushes may be seated by use of a brush seating hone. While starter is operating at medium speed, press seating hone firmly against commutator to cover area contacted by brushes. Brushes should seat satisfactorily in a short period. Blow starter out with compressed air after using seating hone, to remove all particles of abrasive. Do not use

emery cloth or sandpaper to seat brushes. Check pigtail lead connections to be sure they are tight.

Brush Spring Tension

Check brush spring tension. Excessive tension will cause commutator and brushes to wear rapidly. Low spring tension will cause a reduced starter speed, also arcing and burning of commutator and brushes. Replace springs if tension is not as specified in "Specifications" later in this section.

Miscellaneous

Make careful inspection of wires, terminals and all visible parts of starter. Any apparent defects should be corrected immediately.

Unusual noises in the starter may be caused by loose mountings. Worn or dirty bushings may cause noise or slow starter speeds. This requires cleaning and lubrication, or if worn excessively, replacement. Improperly seating brushes may cause slow starter speeds. Brushes can be reseated by a brush seating hone as explained under "Brushes" previously in this section. Bent brush holders should be replaced.

STARTIX

Startix, mounted on bracket above flywheel housing, performs dual functions of starter relay and automatic starter disconnector.

Startix (fig. 28) consists of two solenoids, a vibrating contact arm, and a bi-metal circuit breaker.

Operation

When either "Start" button is pressed, current flow through "IGN" terminal energizes main switch solenoid coil (A, fig. 28). Contacts (C, fig. 28) close, completing circuit to starter (fig. 27), and to coil of relay solenoid (dotted line). Energized relay tends to move lever (G, fig. 28) but heavy current flow to starter through hold-out series coil (D, fig. 28) prevents movement of lever.

As engine fires and begins to overrun starter, Bendix pinion is disengaged from flywheel teeth. Starter current draw is considerably reduced with starter disengaged from engine. Reduced current draw lessens magnetic pull of coil (D, fig. 28), permitting coil (dotted line) of relay solenoid to move lever (G, fig. 28).

Movement causes lever (G, fig. 28) to contact vibrating arm (B, fig. 28) opening contacts (H, fig. 28) which breaks circuit to coil (A, fig. 28). De-energized coil (A, fig. 28) permits contacts (C, fig. 28) to open, breaking circuit to starter. Current flow to relay coil (F, fig. 28) also ceases, permitting lever (G, fig. 28) to return to original position.

In ordinary use, operator releases starter button when engine starts. However, if operator fails to release button, time delay feature prevents immediate re-engagement of starter.

When pressure of lever (G, fig. 28) is released from contact arm (B, fig. 28) arm vibrates for approximately 1 second before coming to rest and closing contacts (H, fig. 28). If start button is still making contact, starter will not be damaged, since ends of pinion teeth merely touch and are deflected from flywheel teeth.

If starting motor stalls under cranking lead, and if starter button is not released, thermostat safety control moves arm (B, fig. 28) to open contacts (H, fig. 28). This has same effect as movement of lever (G, fig. 28) described above. As bi-metal thermostat cools, contacts close. This cycle is repeated until circuit through "Start" button is broken.

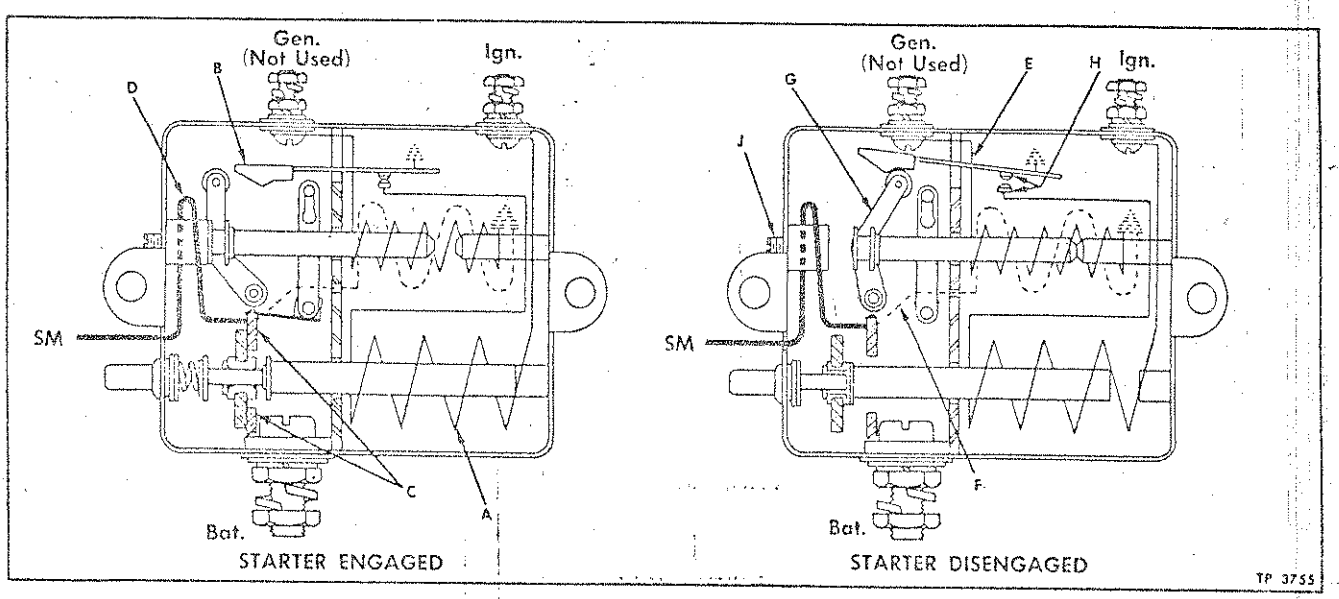


Figure 28—Startix Operation

Maintenance and Adjustment

Startix requires no regular maintenance other than regular inspections to make sure that all terminal connections are clean and tight.

Adjustment screw (J, fig. 28) is set at factory, and should not be changed unless one of the following conditions is evident:

1. Interrupted cranking (repeated attempts to crank at broken intervals).
2. Starting motor overrun (operation of motor after engine starts).

To adjust for interrupted cranking, loosen lock nut and turn screw clockwise slowly until steady cranking is obtained. Turn screw 1/8 turn further, then lock in this position with nut.

To adjust for overrun, loosen lock nut and start engine. Turn screw counterclockwise until startix clicks and starting motor decelerates. Turn screw 1/8 turn further, then hold while firmly tightening lock nut.

CAUTION: Avoid use of startix manual button. If necessary to use, method of operation is important. Press button in hard until bottomed. Release button quickly by sliding finger off side of button.

ANTI-BACKFIRE SWITCH

Anti-backfire switch (fig. 29) is mounted on intake manifold. Switch is a pressure actuated device which breaks control circuit to startix in event of backfire or compression back rock.

Operation

When backfire or reversed rotation occurs, change in intake manifold pressure actuates piston in switch. Movement of piston closes a pair of normally open points (4, fig. 29), one of which is grounded. Momentary ground heats a bi-metal strip which opens a pair of points (3, fig. 29) breaking circuit to startix. Bi-metal strip heats very rapidly, but cooling requires several seconds. As bi-metal cools, points (3, fig. 29) close, completing circuit to startix.

LOW OIL PRESSURE SWITCH

Switch, connected in engine pressure lubrication system, is mounted on right side of engine. Switch is connected electrically to master switch, circuit to switch being energized with master switch in "Cooling" position.

Normally closed contacts of switch are opened when oil pressure exceeds 3 pounds. In operation, switch illuminates "Low Oil" tell-tale, at left of driver, when master switch is turned to "Cooling" position. As engine is started, engine oil pressure opens low oil pressure switch and turns off "Low Oil" tell-tale.

Low oil pressure switch requires no maintenance. In the event "Low Oil" tell-tale fails to illuminate before engine is started, a simple test can be used to determine whether or not switch is faulty. Short switch terminals with a jumper wire. If tell-tale lights, switch is defective; if tell-tale does not light, trouble is elsewhere in circuit.

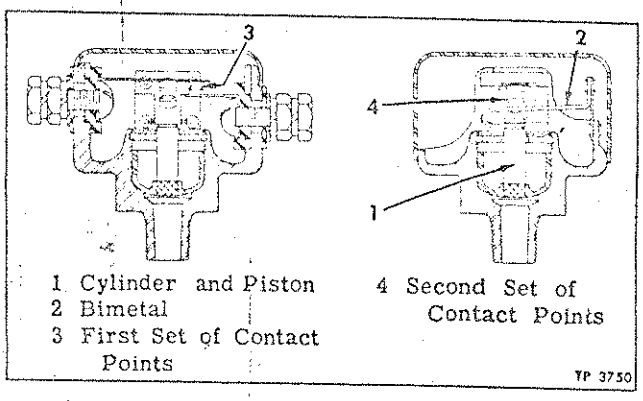


Figure 29—Anti-Backfire Switch

OIL PRESSURE

Oil pressure gauge may be connected at tee on which low oil pressure switch is mounted. Oil pressure should be from 15 to 35 pounds, depending on engine speed, temperature, and grade of oil used.

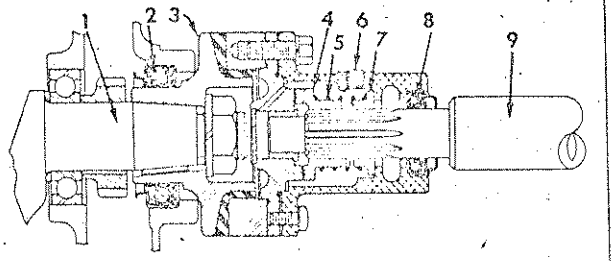
Oil pressure may be adjusted after removing cap on right side of crankcase. Adjusting screw and lock nut are then accessible.

ENGINE TIMING

Electrical timing procedure is described in "Ignition System" earlier in this section.

Both camshaft gear and crankshaft pinion are marked with the letter "C." When engine valves are properly timed, the two letters should be in alignment. Before removing either shaft or either gear check for the "C" marks to avoid necessity for a timing check.

If gear marks are obliterated it will be necessary to time engine at assembly. Set valve clearances on No. 1 intake and exhaust to 0.003" and 0.005" respectively. These are timing clearances only, not running clearances. Turn engine over until No. 1 piston reaches top of stroke. Continue turning until piston drops 3/64" from highest point. This corresponds to 5 degrees travel of crankshaft, at which point intake valve should just start to open, Clearance at No. 1 intake valve should be reduced so that a 0.003" feeler gauge will be pinched. If this is not the case, remesh gears until proper timing is obtained. Reset valves to running clearances before starting engine.



1 Engine Crankshaft
2 Blower Drive Hub Oil Seal
3 Blower Drive Adapter and Hub Assembly
4 Splined Flange
5 Spring
6 Grease Plug
7 Thrust Collar
8 Blower Shaft Oil Seal
9 Blower Shaft

TP 3714

Figure 30—Sectional View of Blower Drive Jaw Clutch

ENGINE MOUNTING

Mounting bolts must be kept tight to prevent shifting of engine, with possible damage to blower clutch, shaft, and bearings. At regular intervals, check mounting bolts and tighten firmly. If bolts are permitted to become loose it will be necessary to remove unit from coach to align blower shaft.

BLOWERS AND CLUTCH

Engine radiator and refrigerant condenser are cooled by air circulated by two blowers. Blowers, mounted on a common shaft, are driven from front end of engine crankshaft through drive jaw type clutch (fig. 30).

When engine is shut off, it stops very quickly due to compressor load. To reduce strain on engine crankshaft, clutch is designed to permit blowers to overrun engine and thus to decelerate at a slower rate than engine. Clutch requires no attention other than periodic tightening of hub bolts. Lubrication is required only if clutch becomes noisy. Refer to Lubrication Chart.

SHAFT ALIGNMENT

Whenever engine or blowers are removed, engine must be aligned with bearing in pillow block. Aligning tool, CS-1504, is available for this purpose.

To align engine and pillow block bearing, remove blowers, clutch, and shaft. Insert end of tool in bearing, then attach other end of tool to drive hub on engine with cap screws. Tighten cap screws firmly and with equal tension.

Turn engine over slowly while observing end of tool in bearing. Tool is smaller than bearing, therefore any misalignment can be readily noted. Correct misalignment by loosening engine mountings bolts and shifting engine as necessary.

BLOWER SHAFT BEARING

Bearing in pillow block requires no periodic maintenance. Whenever unit is removed from coach, apply a few drops of light engine oil to oiler, before unit is installed in coach.

SPECIFICATIONS

ENGINE

Make	Waukesha
Model	121
Bore	2-1/2"
Stroke	3-1/8"
Number of Cylinders	4
Total Displacement - Cu. In.	61
Governed Speed RPM	1400 & 2400
Compression Ratio	6.1:1
Firing Order	1-2-4-3
Valve Lash (Cold)	
Intake	0.008"
Exhaust	0.012"
Oil Sump Capacity (Quarts)	5
Oil Filter Capacity (Quarts)	1/2

IGNITION SYSTEM

Ignition Relay

Make	Delco-Remy
Model	1850505
Air Gap (Points Closed)	0.010"-0.015"
Point Opening	0.030"-0.040"
Closing Voltage	8.5

Distributor

Make	Delco-Remy
Model	1111707
Rotation	
Viewed at Drive End	Clockwise
Viewed at Rotor End	Counterclockwise
Breaker Lever Tension (Ozs.)	17-21

Initial Timing Point . . . . . UDC
Firing Order 1-2-4-3
Breaker Point Gap . . . . . 0.024"
Automatic Advance (Deg.) 24
Manual Adjustment (Deg.) 20

Ignition Coil
Make . . . . . Delco-Remy
Model 1115044
Voltage 12

Spark Plugs
Make . . . . . AC
Type . . . . . #44 Commercial
Gap . . . . . 0.030"

GOVERNOR AND THROTTLE
Engine Speed (RPM)
High 2400
Low 1400

Magnet Valve
Make . . . . . National Pneumatic
Model C-26490
Type . . . . . Exhaust

FUEL SYSTEM
Tank Capacity (Gals) 20
Octane Rating (Min.) 73
Electric Fuel Valve
Make . . . . . Design Specialties
Model B-12-135

Fuel Pump
Make . . . . . AC
Model . . . . . W
Static Pressure (Lbs.) . . . . . 1 - 3-1/2
Capacity . . . . . 1 pint-60 seconds

Carbureter
Make . . . . . Zenith
Model 10261-A
Venturi 16
Main Jet 20
Idling Jet 15
Main Discharge Jet 55-3
Well Vent 18
Fuel Valve Seat 25

Electric Choke
Make . . . . . Pierce
Model AC-1010

AIR INTAKE SYSTEM
Air Cleaner
Make . . . . . Vortex
Type . . . . . Oil Bath

COOLING SYSTEM
Capacity (Quarts) 9
Thermostat
Starts to Open . . . . . 160°F.
Fully open . . . . . 185°F.
Closed . . . . . 148°F.

CRANKCASE BREATHER
Make . . . . . Waukesha
Type . . . . . Oil Bath

OIL FILTER
Make . . . . . AC
Model L-5
Replacement Cartridge C-111

STARTING SYSTEM

Starting Motor
Make . . . . . Delco-Remy
Model 1108557
Brush Tension (Oz.) 24-28
Rotation, viewed from Driving End . Clockwise

No Load Test
Amperes 40
Volts 11.6
RPM 5500

Lock Test
Amperes 260
Volts 9.4
Torque Lbs. Ft. 15

Startix
Make . . . . . Eclipse Machine

Anti-Backfire Switch
Make . . . . . Eclipse Machine

Low Oil Pressure Switch
Make . . . . . AC
Model F-1
Break Pressure . . . . . 3 Lbs. ± 1 Lb.

System Tests and Services

IN THIS SECTION

UNIT REMOVAL

A special dolly, listed under "Special Tools and Equipment" at end of this manual, is designed to facilitate removal and installation of the complete package unit assembly. The use of this dolly is highly recommended, since it eliminates the danger of damaging the unit. For access to inner mounting bolts, refrigerant line connections, and fuel line connections, remove three access plates from inner end of baggage compartment opposite the air conditioning unit compartment.

1. Pump down system as previously directed. Close compressor, liquid receiver, and evaporator shut-off valves. Remove air outlet screens from under unit.
2. Place dolly under unit and raise jacks making sure the pins on top of jacks enter sockets provided in unit frame.
3. Remove door post.
4. Disconnect wiring connector plugs from control box. Disconnect battery cable from startix terminal and tape end of cable.
5. Remove high-low pressure cut-out switch from bulkhead and lay it on top of compressor.
6. Disconnect throttle control cylinder to magnet valve air line at magnet valve. Install plug in magnet valve outlet. Disconnect wires from magnet valve and tape wires to prevent short circuit.
7. Close fuel line shut-off valve, then disconnect fuel lines at frame connections.
8. Disconnect radiator hose and vent line from surge tank.
9. Disconnect refrigerant liquid and suction lines at connections near roof of unit compartment. Seal all lines with moisture-proof tape.
10. Remove bolts attaching condenser upper brackets to coach body. Disconnect jack knife type condenser stop from body. Remove Nos. 1 and 2 spark plugs from engine.
11. Remove all bolts attaching unit frame, center partition, and blower housing support to coach body.
12. Raise jacks slightly. Check to make sure all mounting bolts are removed, and that all wiring, gas lines, etc., are disconnected.
13. Tapping plates are provided on coach frame at inner side of air conditioning unit. To start unit removal, thread bolts through tapping plates against unit frame. Turning bolts in will dislodge unit so it can be readily pulled out on dolly.
14. If vehicle is to be placed in service without air conditioning unit, install temporary side rail (Part No. 2229890), then install removable door post.

UNIT INSTALLATION

1. Place unit beside vehicle and align unit frame with channels in coach body. Then roll into place on dolly. If unit does not go all the way in, long bolts may be used through mounting bolt holes at inner side to pull unit into place. After mounting bolts are installed, long bolts must be removed and replaced with regular mounting bolts.
2. Install all mounting bolts. These include bolts in unit frame, center partition, and blower housing support.
3. Install Nos. 1 and 2 spark plugs in engine. Connect refrigerant lines, fuel lines, and engine radiator hose and vent line. Make sure all connections are tight.
4. Mount high-low pressure cut-out switch on bulkhead.
5. Connect throttle control cylinder air line to magnet valve. Connect wires to magnet valve.
6. Connect wiring connector plugs to control box. Connect battery cable to Startix terminal.
7. Install condenser upper mounting bolts and connect condenser stop to body.
8. Install removable door post.
9. Fill fuel tank and cooling system, and check engine crankcase oil level.
10. Make sure all refrigerant valves are open. After starting unit check entire system for leaks and check compressor oil level and Freon level. Perform service operations given in this section as required.

TESTING FOR LEAKS

Whenever repairs or adjustments have been made to any part of the refrigerating system which necessitate disconnecting regrigerant lines, connections should be tested for leakage before the unit is restored to service. First admit only enough gas into the system to produce 5 or 10 pounds pressure, then test for leaks. If no leaks are found at this pressure, increase pressure 5 or 10 pounds, and test for leaks again. In this way, only a slight amount of refrigerant gas will be lost in the event there is a leak. Final test should be made with system under operating pressure. Large leaks will be indicated by oil seepage and must be repaired immediately.

FREON LEAK DETECTOR

Leak detector, commonly called a Halide Lamp, is a small torch which burns methyl alcohol. Air used in burner is drawn through a flexible tube. Part number and vendor's name and address are listed under "Tools and Equipment" at end of this manual. Operation of leak detector is as follows:

Pressure is produced in the fuel tank by heat of generation at time alcohol is burned in small cup under burner. Alcohol vapor under pressure burns with a green-tinted flame when mixed with air in burner. By holding open end of sampling tube near connections, joints, valves, etc., any traces of Freon would be drawn through the tube to the burner and would be immediately evident. Freon breaks down when coming in contact with the heated copper ring in burner and turns flame blue. In case large amounts of Freon are present, flame will turn a bright purple. Do not confuse change in color with change caused by shutting off air supply. When other types of leak defectors are used, color of flame may be different. The important thing is not the color of the flame, but the change in color when Freon is present.

Instructions are supplied with each leak detector. Only high grade Anhydrous Methyl Alcohol as listed under "Tools and Equipment" at end of this manual should be used in burner.

When refrigerant has been lost, adding refrigerant without knowing cause or location of leak merely postpones corrective measures and increases maintenance costs. At two or three week intervals, go over entire system with leak detector. Check for leaks at the following points:

Sight glasses on compressor and receiver.
Compressor shut-off valves.
Receiver shut-off and charging valves.
High-low pressure cut-out switch.

All connections and joints at condenser, compressor, and liquid receiver.

Compressor shaft seal (check through engine flywheel housing timing hole or drain hole at bottom of housing).

Dehydrator.

Expansion valve.

All connections and shut-off valves in evaporator compartment.

CHECKING FOR AIR IN SYSTEM

Air in refrigerating system causes excessive head pressures and reduction in cooling capacity. Check for air in system as follows:

1. Connect an accurate pressure gauge to tee at compressor discharge valve. Valve must be placed in operating position.
2. Hang an accurate thermometer in air conditioning unit compartment.
3. Allow unit to stand idle for several hours to allow temperatures of all parts to equalize, then note thermometer and gauge readings.
4. Compare readings with figures previously shown in pressure-temperature chart. If pressure gauge shows a reading of more than 3 pounds higher than pressure shown on chart for the existing temperature, air must be purged from system.

PURGING THE SYSTEM

If only a small amount of air is indicated in the system, it may be purged from top of each unit.

1. To purge air from top of compressor loosen oil filler plug in top of compressor shell.
2. To purge condenser, loosen plug on manifold.
3. To purge evaporator, loosen equalizer tube fitting at expansion valve.

If a large amount of air is indicated, it may be necessary to pump the refrigerant into a Freon tank and purge the air from the tank. To accomplish this, pump the system down into the receiver and close receiver shut-off valves. Connect tube to receiver charging valve and to Freon tank. Open charging valve, then heat the receiver with hot water and cool the Freon tank with cold water to transfer refrigerant from receiver to tank. Let tank stand for several hours, bleed air off from top of tank, then transfer the refrigerant back into the liquid receiver.

PUMPING DOWN THE SYSTEM

In order to perform any service operations on the system which necessitate disconnecting refrigerant lines, it is necessary to first pump down the system to prevent appreciable loss of refrigerant. To pump down the system means to pump all of the liquid refrigerant into the liquid receiver.

1. Close "liquid out" valve on receiver by removing valve cap and turning valve stem in until valve seats.
2. Connect compound gauge to gauge port on compressor suction valve. Open suction valve to operating position.
3. Start engine and run until low pressure cut-out switch stops it, observing pressure on gauge.
4. After suction pressure builds up to low pressure switch cut-in point (22 pounds), again start engine and run until it cuts out. Repeat on and off cycle several times, then close compressor suction valve.

TO EVACUATE THE SYSTEM

Whenever the complete refrigerant charge has been lost due to leakage, it is necessary to evacuate the system before recharging. Air in lines cause high head pressures and loss of capacity. In case of emergency where vacuum pump is not available, system may be blown out with Freon to eliminate air in system. This should only be done in case of emergency, since considerable Freon is used which is very costly; also, vacuum pump is more satisfactory. Any reliable refrigerant vacuum pump may be used.

Following procedure will evacuate entire system:

1. Connect vacuum pump to charging valve.
2. Be sure all valves are in operating position.
3. Operate vacuum pump to give maximum vacuum for at least 2 hours.
4. Close charging valve with pump running, then disconnect pump.

NOTE: In case only a small portion of the system has been open to atmosphere, that portion of the system may be blown out with Freon gas or evacuated as desired.

CHARGING SYSTEM

Before adding any refrigerant, repair any leaks and then proceed as follows: (Refer to fig. 8).

1. Remove cap from 1/4" flare connection on charging valve on receiver.
2. Install a length of clean 1/4" tubing to this 1/4" connector.
3. Connect other end of tube to refrigerant bottle. Admit a little gas from tank to drive out air. Tighten flare nuts at both ends of 1/4" tube. Turn bottle over so that outlet valve is down.
4. Close receiver valves and open bottle valve.
(*) 5. Open charging valve until desired weight of refrigerant has been added, weighing bottle at intervals. Upper end of bottle can be heated slightly to force refrigerant into receiver a little faster. It is preferable to use warm water for heating bottle.
6. Close bottle valve. Close charging valve. Remove 1/4" line and replace cap on charging valve.
7. Open receiver liquid out valve just enough to admit a little gas into system, then close valve and test system for leaks as previously directed.

By warming bottle and feeling of it, liquid level may be ascertained (coolness will be noted from liquid level down). Amount of gas being drawn into unit can be estimated by knowledge of quantity contained in bottle at start and checking fall of level, or better still by weighing bottle before and during and after charging operation.

Goggles should be worn whenever there is slightest possibility of Freon coming in contact with face, because Freon evaporates and cools so rapidly, it will cause an injury similar to a burn.

* When complete system has been evacuated, full charge of Freon-12 to be added is 25 pounds.

Lubrication and Inspection

IN THIS SECTION

INSPECTIONS

The following inspections are recommended at regular intervals. Until service experience can determine specific inspection and service periods, such services should be accomplished at more frequent intervals. Refer to "Lubrication" later in this section for detailed lubrication information.

Inspection & Service	Intervals Recommended
1. Clean Condenser and Radiator	Daily if necessary
2. Liquid Receiver Refrigerant Level Check	Daily
3. Compressor Oil Level Check	Daily
4. Dehydrator Strainer Clean and Refill with Silica-Gel	After opening system
5. Refrigerant Valve Caps (7) Keep Tight	Check frequently
6. Clean and Service Air Filters	As necessary
7. Check System for leaks	As necessary
8. Clean Evaporator	As necessary
Power Plant	
9. Crankcase Oil Level	Daily
Drain & Refill	Every 50 hours
10. Replace Oil Filter Cartridge	At Engine Oil Change
11. Clean Crankcase Breather	At Engine Oil Change
12. Ventilating Valve - Clean	At Engine Oil Change
13. Clean Air Intake Pipe Check and Drain Valve	As necessary
14. High and Low Engine Speed Check	As necessary
15. Tune-up Engine	50 hours
16. Lubricate Units in System	Refer to "Lubrication"

LUBRICATION CHART

The following chart lists lubricating points, recommended lubrication intervals, and types. References are made to other portions of the manual for special cleaning and lubricating instructions whenever necessary.

Lubricating Point	Service and Intervals	Lubricant
Compressor Oil	Check daily - Replenish if necessary (Page 16)	ES-(Note 1)
Evaporator Blower Motors	2 Oil cups - At Major Inspections	E-(Note 2)
Air Filters	Clean and Service as Necessary	See Note 3
Engine Crankcase	Check level daily - First 100 hours (SAE-20) - drain and refill every 50 hours thereafter (SAE-30)	E-(Note 2)
Oil Filter	Replace Cartridge every Engine oil change	
Crankcase Breather	Clean and oil every engine oil change	E-(Note 2)
Air Cleaner	Clean and oil every engine oil change	E-(Note 2)

Distributor	Oil wick under rotor - Monthly	E-(Note 2)
	Cam - Monthly Petrolatum	Sparingly
Blower Drive Clutch	If Clutch is Noisy	S-2-(Note 4)
Throttle Control Cylinder	At Assembly	C-(Note 5)
Fuel	Add 1/2 pint SAE 10 Engine Oil To every 12 Gallons of Fuel	
Control Linkage	Light Oil Sparingly When Necessary	

LUBRICATION NOTES

Note 1. Use only SAE 60 engine oil of good quality. Use only from sealed quart containers. Do not use bulk oil.

Note 2. Crankcase. Use good grade of SAE 20 engine oil for the first 100 hours; then drain and refill with SAE 30. Replenish as necessary to keep level to full mark. Drain and refill at least every 100 hours. Capacity 5 qts.

Crankcase Breather. Clean element and re-oil with good grade of engine oil SAE 30.

Air Cleaner. Clean and refill with good grade of engine oil SAE 30

Evaporator Motors, Starting Motor, and Control Linkage. Use SAE 20 engine oil.

Note 3. Air Filters. Clean as directed on page 20. . "Odorless" oil on elements should be used sparingly.

Note 4. Blower Drive Clutch. At assembly, or if noisy, pack full. Use a good grade of long-fibre non-fluid sodium soap grease having a high melting point.

Note 5. Throttle Control Cylinder. Remove cap and lubricate with a good grade of calcium or sodium soap chassis lubricant.

Trouble Shooting

When determining the cause for inefficient cooling, the most common causes should be checked and corrected first - then proceed to the next common cause. The following chart lists the most common symptoms, probable causes, and remedy. Page numbers shown indicate where services and procedures can be found in this manual.

IMPORTANT

ONE OF THE MOST COMMON CAUSES FOR INSUFFICIENT COOLING IS A DIRTY, CLOGGED CONDENSER AND RADIATOR. THIS CONDITION SHOULD BE CHECKED FREQUENTLY AND CORRECTED AS EXPLAINED ON PAGE 16.

1. Evaporator Blowers Not Running
   - (a) Fuse Blown ..... Page 11
   - (b) Defective Blower Motors ..... Repair or Replace
   - (c) Loose Electrical Connections ..... Tighten
   - (d) Defective Magnetic Switch ..... Page 21

2. Dehydrator Clogged ..... Page 16

3. Air Filters Clogged ..... Page 20

4. Compressor
   - (a) Too Much Oil ..... Page 16
   - (b) Compressor Valves Not Opened Correctly ..... Page 14

5. Improper Engine Speed
   - (a) Speed Control Requires Adjustment ..... Page 31
   - (b) Engine Modulation Thermostat Requires Adjustment ..... Page 21
   - (c) Magnet Valve, Defective ..... Page 31

6. Low Freon
   - (a) Leaks in System ..... Page 47
     Recharge System ..... Page 48

7. Defective Expansion Valve
   - (a) Capilliary Tube Broken ..... Page 17
   - (b) Equalizer Tube Restricted ..... Page 17
   - (c) Gummed Cage ..... Page 18
   - (d) Check Adjustment for Super Heat ..... Page 18

8. Engine Cuts Out or Fails to Start at High Outside Temperature
   - (a) Dirty Condenser ..... Page 16
   - (b) Too much Freon ..... Page 18
   - (c) Air in System ..... Page 47
   - (d) Carbon in Engine Cylinder Head ..... Clean
   - (e) Restricted Fuel Lines ..... Page 33
   - (f) Defective Fuel Pump ..... Page 33
   - (g) Defective Solenoid Type Fuel Valve ..... Page 33
   - (h) Defective Carbureter ..... Repair or Replace
   - (i) Engine Modulation Thermostat Requires Adjustment ..... Page 10
   - (j) Over Heated Engine ..... Correct
   - (k) Defective Ignition ..... Tune-up Engine

9. Engine Loses RPM at High Outside Temperature
   - (a) Any of the above items (a) through (i) will cause engine to slow down.

Tools and Equipment

Reference is made to special tools, equipment, and material in this manual. These tools and equipment, or equivalent, are necessary and are recommended to more readily and efficiently accomplish certain service operations. These tools and equipment, however, are not supplied by the coach manufacturer. In many cases, they may be purchased locally, except those listed under "Special Tools." In the event purchase cannot be made locally, names and address of suppliers are listed

SPECIAL TOOLS

Package Unit Dolly (CS-1503)
Blower Shaft Alignment Tool (CS-1504)

Vendor ..... Curtiss-Smith Mfg. Co. ..... Pottstown, Pa.

C-21290 .....Magnet Valve Upper Valve Holder
C-13622 .....Magnet Valve Upper Valve Guide
C-21300 .....Magnet Valve Lower Valve Holder
C-14022 .....Magnet Valve Push Rod Gauge

Vendor ..... National Pneumatic Co. .....Chicago, Ill.

EQUIPMENT

Thermometer (for use in conjunction with expansion valve adjustment) #65-Bremote reading dial
James P. Marsh Corp. ..... 2090 Southport Ave., Chicago, Ill.

Tachometer (for engine speed adjustment) Model V Electric - 6 to 12 volts
Sun Mfg. Co. .....6323 Avondale Ave., Chicago 31, Ill.

Presto-Lite Torch and Cylinder of Gas (for soldering refrigerant fittings)
Air Reduction Sales Organizations

Refrigerant Pressure Gauges (0 to 300 lbs.)
James P. Marsh Corp. ..... 2090 Southport Ave., Chicago, Ill.

Oil Pressure Gauge (for engine) - 0 to 50 lbs., 1/8" pipe thread-Purchase locally

Leak Detector (#390)
Justrite Mfg. Co. ..... 2061 North Southport Ave., Chicago, Ill.
or
Frigidaire Leak Detector - SA2136
Frigidaire Corporation ..... Service Sales Dept. .....Dayton, Ohio

Vacuum Pump and Gauge (Should be capable of pulling 28" Mercury vacuum). May be purchased from any of the following vendors:
Central Scientific Co. ..... 1700 Irving Park Road, Chicago, Ill.
Fisher Scientific Co. ..... 711-723 Forbes St., Pittsburgh, Pa.
Gast Mfg. Co. ..... 119 Hinkley St., Benton Harbor, Mich.
Kerr Mfg. Co. ..... 6083 12th St., Detroit 8, Mich.

MATERIALS

Anhydrous Methyl Alcohol - Obtain locally or from:
Fisher Scientific Co. ..... 711-723 Forbes St., Pittsburgh 19, Pa.

Freon (F-12) Refrigerant ..... Purchase locally

Solder (95% tin - 5% antimony) - Type 95 Solder - Obtain locally or from:
Chase Brass and Copper Co. Inc. ..... Waterbury, Conn.
or
The American Brass Co. .....Waterbury, Conn.

Nokorode Soldering Paste - Obtain locally or from:
M. W. Dunton Co. ..... Providence, R. I.

Silica Gel - Obtain locally or from:
Davidson Chemical Co. ..... 20 Hopkins, Baltimore, Md.